THE

CINCINNATI QUARTERLY

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EDITOR AND PROPRIETOR,

S. A. MILLER.

VOLUME I.

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THE JOURNAL.

This vicinity is not surpassed in geological interest by any locality in the United States. For the study of fresh water shells and fishes, probably no part of the world furnishes a more bountiful and desirable supply for the hand of the conchologist and ichthyologist. Other departments of natural history, too, are not without their objects of special beauty and attraction. Indeed, wherever we turn, we are liable to be met by something new, not only to ourselves, but to the scientific world.

The hills surrounding Cincinnati have been worn and lined with paths by Locke, Anthony, James, Dyer, and other indefatigable paleontological collectors, and yet the hunters have been as successful in the last twelve months in the discovery of new species and rare and remarkable specimens as they have ever been in any former year; and we have every reason to believe that future years will be quite as prolific as the past have been. Probably not half the fossil species belonging to the "Cincinnati group" have yet been found and described. Here, then, is a field that will continue for a long time to come to attract the attention of the paleontologists, not only of our own country but those abroad, with an increasing interest, as every new species is found, figured and described. What is here said in regard to paleontological discoveries may be repeated as to nearly every other branch of natural history.

In such a locality as this the schools should afford every facility for the acquirement of a knowledge of the objects that surround us, and a journal devoted to the publication of scientific matters pertaining to the locality ought to be supported by able correspondents and willing subscribers. About the close of the last year I determined to attempt the publication of such a journal, and now offer this issue to the public, though much of it is necessarily selected matter.

It will not compare with scientific journals long established and edited by a corps of able contributors, but, if sustained at all, there is no reason why the local talent can not, at an early day, produce a journal of original matter equal to any published elsewhere.

The Column of Heterocrinus heterodactylus; by S. A. Miller.

The column of the *Heterocrinus heterodactylus* may be divided, for description, into three parts: 1st, that part within about two inches of the base; 2d, that part which follows until within about two inches of the head; 3d, that part within about two inches of the head. This measurement will be applicable to a medium-sized specimen.

When the column emerges from the base it is composed of numerous small pieces, that appear to interlock with each other, but at the distance of about one fourth of an inch from the base each plate of the column is composed of five pieces, representing the five partite appearance of the column, and have ceased to interlock with each other. The column is here quite round, smooth and regular, each plate appearing to be of nearly the same thickness. From one fourth of an inch to one half of an inch from the base there are 30 plates, or 150 pieces. At the distance of one half an inch from the base the five partite structure begins to be less distinct, and the plates seem to be alternately thicker and thinner. This appearance becomes more marked as you move up the column, until at the distance of one inch from the base, the pieces of the plates have coalesced, so that no five partite structure is now visible. The smaller intermediate plates now grow thinner and thinner, until they have completely anchylosed and blended with the larger plates, and become invisible at the distance of two inches from the base. As the intermediate plates grow thinner, the column becomes more beaded in its appearance, so that when they have completely anchylosed and blended with the larger plates the column presents the appearance of a string of small beads, each of which is a little less than half the length of its diameter.

2d. The length of the second part of the column is unknown, but the same beaded appearance evidently continues until it approaches within about two inches of the head, when it assumes the pentagonal form, as hereafter described. From the quantity of fragments of columns found, it is likely that this second part was two or three feet, or even more, in length. I have seen single pieces of it from six to nine inches in length. The specimen from which the above measurements were taken shows the beaded part of the column to be composed of forty plates to the inch. It is in my collection, and shows five inches of the column attached to the base. The plates in the beaded part of the column are thus seen to be three times as much in thickness as they are within the first half inch from the base.

3d. The third part of the column, commencing at the head, and going down (though heretofore treated as representing the whole of the column), is described by Prof. Meek (Ohio Paleontology, vol. i., page 13), as follows:

"Column, comparatively, rather large and strong, somewhat distinctly pentagonal near the body, with more or less rounded angles, and composed of alternately thicker and thinner pieces; the latter not forming continuous discs, but consisting each of five minute sections, disconnected from each other, and ranged as minute transverse nodes, coincident with the five angles of the column, and with the minute pieces at the connection of the latter with the body, that are described above as sub-basals. Further down the column gradually becomes nearly cylindrical, and the little intercalated pieces more and more developed, until they coalesce and form complete discs, scarcely distinguishable from the others."

Only the pentagonal part of the column was known to Prof. Hall when he described the species (Pal. of N. Y., vol. i., page 279).

The base is quite small in proportion to the size of the column, and frequently two or three, or even more, columns are found closely huddled together in one base, attached to the column of a *Glyptocrinus decadactylus*, or to the column of a *Heterocrinus simplex*. It is rarely ever found except attached to the column of some other crinoid, and from the frequency with which it is found in clusters, one upon the other, or two or more in the same base, it would seem to have been a parasite. It may not have been, however.

The *Heterocrinus heterodactylus* is found at all elevations about Cincinnati, from low water-mark to the top of the hills, though good specimens are by no means common at any elevation. Taylor's creek, back of Newport, Ky., a short distance beyond the first tollgate, and limekiln hollow, at the head of Deercreek, have furnished a great many heads, bases, and columns of this species.

Ceraurus Pleurexanthemus—(Green).—The pygidium of a trilobite, described in the Ohio Paleontology, on page 169, as *Acidaspis ceralepta* (?) and figured on plate 14, fig. 8, is undoubtedly the pygidium of a *Ceraurus pleurexanthemus.*

Genus *Pasceolus.*—(Billings.)

This genus was proposed by Billings, as he says: "For certain ovate or subglobular bodies, resembling the *Ischadites Kœnigi* of the Silurian system, but differing therefrom in the form of the plate-like markings of the casts of the interior, which in this genus are pentagonal or hexagonal instead of quadrangular. A specimen from Anticosti shows that the animal was inclosed in a thin leather-like sack, and attached to the bottom by a short tubular continuation of this external covering. Its affinities appear to be with those of the *Tunicata*." —[Geological Rep. of Canada for the year 1857, page 342.]

Two species were described from Canada by Prof. Billings: *P. Halli* and *P. Globosus.* In the discussion of these species (Paleozoic Fossils, vol. i., page 392), he says:

"Eichwald, in his Lethœa Rossica, has described and figured two species, *Cyclocrinus Spaskii* and *C. exilis,* which appear to me to be either congeneric with our two, or at least to belong to the same family. Both of Eichwald's species are small globular bodies, covered with hexagonal or pentagonal plates. The plates of *C. Spaskii* have a tubercle in the center, and a number of obscure rounded ridges radiating to the sides. He says there is a small oral orifice on one side, and on the side opposite a rudimentary pedicle. One of his figured specimens is covered with a tubular incrustation, consisting of small cells, which he considers to be a part of the integument itself; it may be, however, a coral. A fragment of one of the specimens of *P. Halli,* from Anticosti, is incrusted in precisely the same manner, with what I take to be a species of *Stenopora.* Eichwald places his genus among the Cystidea; but the more general characters, such as a jointed crinoidal column, the arms or pinnulæ, and the peculiar orifices which characterize all true Cystideans, are not forthcoming. It is barely possible that his view may be the correct one."

"The fossil called *Sphæronites tessalatus* (Phillips), from the English Devonian rocks, has the surface covered with hexagonal plates, and resembles, in general aspect, a species of *Pasceolus.* Mr. Pengelly has figured a specimen in the "Geologist," vol. iv., which shows the interior covered with a net-work of vertical and horizontal ribs, giving the appearance of the inner surface of the specimen of *Receptaculites calciferus.* He proposes a new generic name, *Sphærospongia,* for it. If the specimen figured by him be truly of the same species as that described by Phillips, it would seem that an internal structure, like that of *Receptaculites,* is not inconsistent with an integument of hexagonal instead of quadrilateral plates. I do not see, however, how the net-work figured by Mr. Pengelly can be made to fit hexagonal plates, in the way that the squares formed by the stolons of *Receptaculites* are adjusted."

"M. M. Edwards and Haime have referred Eichwald's genus *Cyclocrinus* to the *Zoantharia*. Whether they are right or not with regard to the Russian species, I can most confidently assert that *Pasceolus* is not a coral. It may be allied to *Receptaculites*, but its true zoological position is quite undecided at present."

In describing the *P. Halli*, he says: "A little below the mid-height of the body there is a small circular elevation, which appears to mark the place of an orifice; but as the integument is not preserved in this part, it can not, at present, be positively determined whether there was an aperture here or not. All that can be said is, that there appears to have been an orifice where this elevation occurs. The specimens collected are all casts of the interior, but of the one figured a portion of the integument remains attached to the matrix. It is about one third of a line in thickness, of a translucent horny color, the surface covered with minute corrugated wrinkles, just visible to the naked eye. No sutures can be distinguished, and the form of the plates can only be made out as so many obscure convexities on the outside. But, where the integument is removed, the cast shows the place of the sutures most distinctly, and that the plates were deeply concave on the inside."

The *Lunulites* (?) *dactioloides*, of Owen, which was placed provisionally in the genus *Pasceolus* by Meek and Worthen (Ill. Geo. Sur., vol. iii., page 345), is found in the Niagara group of the Upper Silurian, and the pits on the convex side are described as of "uniform size, and each one perforated in the middle by a minute circular opening, passing into the interior; while those of the under or flat side are imperforate, and diminish in size from the periphery toward the center."

Pasceolus Darwini.—(S. A. Miller.)

Upper half of body hemispherical; lower half slightly depressed from the hemispherical form, and having a central circular depression marking the place where the column or pedicle that supported the body was attached. In casts, the entire surface is marked by closely crowded pentagonal and hexagonal depressions, about a line in diameter, in specimens $1\frac{1}{4}$ inches in diameter.

Usually compressed, so as to show a somewhat angular periphery, but good specimens show a round periphery, without change in the uniformity of the depressions.

It is sometimes found partly incrusted with a bryozoum, but it is generally clean, showing clearly the depressions, even in specimens very much compressed.

The incrusting bryozoum also shows pentagonal depressions, which clearly proves that the pentagonal depressions in the *Pasceolus* were filled with plates that were a little convex on the outer surface. Some

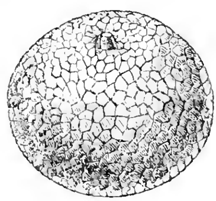

Fig. 1. *P. Darwini* under surface.

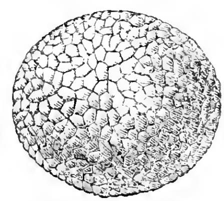

Fig. 2. *P. Darwini* upper surface.

[These figures are not shaded so as to show the depressions, and the specimens are marked much more regularly pentagonal than the figures.]

specimens show convex pentagonal elevations, but the material in the convex elevations does not appear to be different from other parts of the surface, no part of which shows any cellular structure. The pentagonal concave depressions in the bryozoum appear perfectly smooth, thereby indicating that the plates of the *Pasceolus* were smooth.

One specimen has a perforation about forty-five degrees from what appears to be the apex, but whether it marks an opening to the interior or not I am unable to say. If it does, however, it would seem strange that out of fifty other specimens, nearly as good, none of them show anything of it. I broke one specimen into two parts, and polished the surfaces, but discovered no cellular structure.

Fragments and poor specimens are rare on the hills back of Cincinnati, at an elevation of about 400 feet above low water-mark. I found good specimens about two miles south of Maysville, Kentucky, in a railroad cut, that came out of a layer of marl, about two feet in thickness, between the harder stratified rocks. In the same excavation I found *Glyptocrinus decadactylus*, *Orthis sinuata*, *Stellipora antheloidea*, large *Orthis lynx*, and other fossils that are found at Cincinnati, from 350 to 450 feet above low water-mark.

Pasceolus Claudei.—(S. A. Miller.)

Body spherical, without any depression where the column or pedicle was attached. Entire surface marked by closely crowded pentagonal or hexagonal depressions, about $\frac{1}{30}$th of an inch in diameter. Diameter. $\frac{1}{2}$ to $\frac{3}{4}$ of an inch.

It differs from *P. Darwini* in size, and in having no depression where

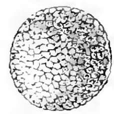

Fig. 3. *P. Claudei*, upper surface.

[The pentagonal depressions are not as regular in the figure as they are on the specimen.]

the pedicle was attached. It is possible that it might be the young of *P. Darwini*, but at present I think it is a distinct species.

Found associated with *P. Darwini*, about two miles south of Maysville, Kentucky, but not found at Cincinnati, nor elsewhere, so far as yet known to me.

Glyptocrinus Subglobosus.—(Meek.)

Is so far separated from *G. Dyeri*, that it should be regarded as a good species. It is treated as only a variety of *G. Dyeri* in the "Ohio Paleontology," page 34, though Prof. Meek says that it is quite possible that it may be a distinct species. It is undoubtedly farther separated from *G. Dyeri* than the latter is from *G. decadactylus*, and had Prof. Meek had other specimens before him it is more than likely he would have treated it as a distinct species.

Remarks on the Genus Conchicolites of Nicholson.—(S. A. Miller.)

Genus *Conchicolites* (Nicholson.) [Am. Jour. of Science and Arts, March, 1872, and Lond. Geo. Mag., Feb., 1873, vol. x., p. 54.]

"Animal social, inhabiting a calcareous (?) tube, attached in clustered masses to some solid body. The tube conical, slightly curved, attached by its smaller extremity. The wall of the tube thin, its external surface devoid of longitudinal striæ. The tube thin, composed of short imbricated rings, but apparently destitute of any cellular structure. Cast of the tube composed of short conical rings, its surface completely smooth, and destitute of striæ or furrows."

Conchicolites corrugatus (Nicholson).

"Tubes growing socially in clustered masses upon the shells of molluscs; calcareous; destitute of vesicular structure; conical, and gently curved. Attached by their smaller extremities, sometimes for the space of a line or more; and either partially free, or contiguous to one another throughout the remainder of their course. Length of the fully grown tube ½ inch or a little more; diameter of tube at mouth $\frac{1}{10}$th inch. Tube composed of conical, imbricating rings, about forty in the space of an inch (about four in the space of $\frac{1}{10}$th inch), giving the tube a strongly annulated appearance."

The specimen figured and described as above was from the collection of Dr. H. H. Hill, of this city, though he received no credit for it, and was found on the hills back of Cincinnati, where other specimens have also been found. Prof. Nicholson says of the specimen further:

"The exquisite preservation of the specimen from which the above description is taken enables me to settle definitely certain points connected with the structure of *Conchicolites*, about which my specimens of *C. gregarius* had left me in doubt. It is now certain, as I had previously conjectured, that the tubes in this genus agree with those of the modern *Serpulæ* in being calcareous, and that they differ altogether from the extinct genus *Cornulites*, in being altogether destitute of any cellular structure. They differ from *Serpulæ* in having the tubes composed of a succession of imbricated rings, the wider ends of which are directed toward the mouth of the tube. From the extinct *Ortonia*, again, they differ not only in the circumstance just mentioned, but in their social clustered habit of growth, and in the fact that the tube is not attached along the whole of one of its sides."

"The specimen exhibits the tubes of more than thirty individuals of *Conchicolites corrugatus* attached to the spire of *Cyclonema bilix*, The tubes are all attached to the shell by their smaller ends, and radiate from their points of attachment, somewhat like the spokes of a wheel. Each tube is conical, circular, or nearly so, in section, and widening out gradually from its apex to its mouth. When carefully examined, it can readily be made out that the tube really consists of a succession of short, calcareous rings, of a conical form, inserted one within the other—this structure being especially perceptible in the interior of the broken tubes. From the exterior, however, the appearance is more that of a succession of strongly marked ridges or annulations, which completely surround the tube, and are separated by slight depressions or flattened interspaces. None of the tubes are perfectly straight, but all are more or less curved, especially toward their attached ends. The extent of the attached portion of the tube varies, being mostly from one to two lines. Their unattached portions run generally (in any two contiguous tubes), more or less, nearly parallel to one another; but though in contact in many instances, it is doubtful if they are actually adherent, and they are most probably not so.

Distinguished from *C. gregarius* "by its greater average length, and much greater diameter, by its much less closely crowded habit. and by its much more strongly marked annulations."

After Prof. Nicholson had founded the genus *Conchicolites* for these singular Tubicolar Annelides in March, 1872, he founded another genus, to wit, *Ortonia*, in October, 1872, for the reception of other Tubicolar Annelides that do not seem to be removed from *Conchicolites* by more than specific differences. An examination of the three species described by him in any good cabinet in this city, to wit, *C. corrugatus O. conica*, and *O. minor*, and a comparison with his descriptions of each of them must convince a person that they all belong to the same genus *Conchicolites*, and if, as generally believed, *Ortonia conica* is the same that Prof. Hall has had from this place, and identified with *Tentaculites flexuosa* of New York, which name it has borne here for many years, the names will be, when written in full, *Conchicolites corrugatus*, *Conchicolites flexuosa*, and *Conchicolites minor*.

The following is the generic description of *Ortonia*:

Genus *Ortonia* (Nicholson), October, 1872. [London Geological Magazine, vol. ix., p. 446.]

"Animal solitary, inhabiting a calcareous tube, which is attached along the whole of one side to some foreign body. Tube slightly flexuous, conical, in section cylindrical, or somewhat flattened laterally, and subtriangular. Walls of the tube thick, cellular along the surface opposite to the attached portion, markedly annulated along the sides."

"In shape the tubes are markedly conical, their section being circular, or at times somewhat trigonal. Almost all the tubes, though in the main straight, are more or less curved and bent toward their smaller, closed extremities. The widest extremity of the tube opens by a more or less nearly circular aperture; and the continuity of the tube, from its open to its closed extremity, is not interrupted by any internal septa. The surface-characters of the tubes are of a very remarkable character. Upon the surface, diametrically opposed to that along which the tube is attached to the shell, the tube is of a cellular character, exhibiting numerous rounded pits or alveoli, which strongly remind one of the peculiar cellular structure of the tube of *Cornulites*. This peculiar structure occupies a narrow belt running down the tube, along its dorsal or free surface; and from both sides of this belt there proceeds a series of strong, annular ridges, or rings, which pass round the tube, to disappear on its fixed margin. These rings are not separated by secondary intermediate annulations, nor do they exhibit any longitudinal striation. Sections of the tubes, however, show that these rings are just as visible on the interior of the tube as they are externally."

"No reasonable doubt can be maintained as to the zoological position of *Ortonia*. It is unquestionable that we have to deal here with a true Tubicolar Annelide, nearly allied to the recent *Serpulæ*. *Ortonia* is still more nearly related to the extinct genus *Cornulites*, from which it differs in its much smaller size, and in being attached along the whole of one side, instead of by its smaller extremity only. It differs, also, in having the peculiar cellular structure of the tube confined to a definite portion of its surface, and in being altogether destitute of longitudinal striation. From *Conchicolites*, again, *Ortonia* is distinguished by the much more complete mode of its attachment, and by the fact that the tubes are never attached socially, in clustered masses, growing side by side, as is the case in the former genus."

The specific character of *Ortonia minor* [Nicholson, February, 1873. Lon. Geo. Mag., vol. x., p. 26], is as follows:

"Tube calcareous, solitary, attached by the whole of one side to some foreign object. Length of tube from $\frac{1}{10}$th to $\frac{3}{20}$ths of an inch; diameter at mouth from $\frac{1}{20}$th to $\frac{1}{25}$th of an inch. Tube marked with transverse ridges or annulations, which are sometimes faintly marked on the side opposite to the attached surface, and the number of which is about fifteen in the tenth of an inch. Tube, in general, strongly curved toward its smaller extremity."

He says: "It does not appear to have any cellular structure of the tube. In *Ortonia conica*, however, this cellular structure is confined entirely to a small portion of the tube (namely, to that portion opposite to the attached surface), and the absence of even this in the present shows that it can not be regarded as a generic character. The only approach to the same structure which I can detect in *Ortonia minor* is, that the transverse rings, or annulations, which surround the tube, become faint or obsolete on the side opposite to the attached surface. Even this, however, is by no means constant, and the rings are sometimes completely continuous over the whole unattached surface of the tube."

"Though often occurring in great numbers together, the tubes of *Ortonia minor*, like those of *Ortonia conica*, are, strictly speaking, solitary; that is to say, they do not, like the tubes of *Serpulæ* or *Conchicolites*, interfere with one another, or come into contact, except accidentally. The tube is generally pretty nearly circular in section, though sometimes slightly trigonal, conical, and always more or less curved. Sometimes it is simply curved like a horn; sometimes it is curved like the letter S; and sometimes the smaller extremity is twisted into a flat spiral. I can detect no longitudinal striation, but the tube is covered with very numerous transverse ridges (at least 150 in the space of an inch), which are generally better marked on the sides than on the back of the tube. In very small, presumably young specimens I have been unable to determine the existence of these ridges, and even in fully grown examples they are more strongly marked in some than in others. The tube is always attached along its whole length, and in no case is any portion free, as is the case in *Conchicolites*."

Prof. Nicholson had other specimens from Cincinnati, of which he said:

"They consist of minute, conical, flexuous or curved tubes, about $\frac{1}{10}$th inch in length, opening by a circular aperture at their widest extremity, and having their surface wrinkled with irregular rings or annulations. In all their essential characters these tubes seem to agree with *Ortonia minor;* but they differ in the very important point that they are not attached to any foreign body, but, on the contrary, are perfectly free. I do not think they can possibly be referred to *Tentaculites*, since they are flexuous, or in some cases irregularly curved, while they are destitute of the strong and regular annulations of the typical species of this genus. Nor can they be referred to *Ortonia*, unless we believe their occurrence in a free state is an accidental circumstance, due to their having become detached from the body on which they grew, prior to fossilization. This is a possible explanation, though an unlikely one. At present I am inclined to believe that we have here a Tubicolar Annelide, which, like *Ditrupa*, was free in habit; but I shall delay naming and describing these remarkable fossils until I may be provided with more ample materials."

Ortonia conica (Nicholson), October, 1872. [London Geological Magazine, vol. ix., p. 448.]

The *Ortonia conica* is described as follows by Prof. Nicholson:

"Tubes growing attached to the shell of some mollusc, varying in length from $\frac{1}{4}$ to $\frac{1}{2}$ inch, with a diameter of about $\frac{1}{10}$th of an inch at the mouth. Lateral annulations of the tube varying in number from 30 to 35 in the space of an inch. Surface smooth and completely destitute, so far as observed, of longitudinal striæ. Tubes truly solitary. Location and position, Cincinnati, Ohio."

The specimen here engraved (fig. 4) is from the same cart load of earth that produced the specimen figured by Prof. Nicholson in the

Lon. Geo. Mag. They were from the stone quarry on the east side of the Avondale pike, near the top of the hill, at the head of Deercreek. This specimen is a better one than that which Prof. Nicholson had, and clearly shows longitudinal striæ under a magnifying glass, which are barely visible to the naked eye. Why the tubes should be called solitary I am unable to imagine, for they are generally found in clusters, as shown in the figure. Sometimes, however, a single one is found

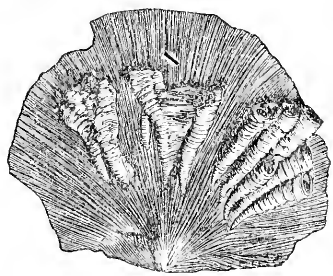

Fig. 4. *Conchicolites* (*Ortonia*) *conica*. Nicholson.

loose, or attached to a coral or a shell, or laying flat on a rock. Whether single or in clusters they are not confined to the shells of "some mollusc," but are found attached to shells and corals indiscriminately, and as frequently on a slab, without attachment to either shell or coral, as anywhere else.

The external surface of the *Conchicolites corrugatus* is not destitute of longitudinal striæ, as asserted by Prof. Nicholson, but, on the contrary, such striæ are plainly visible with an ordinary glass on good specimens, and they can be detected with the aid of a good glass on the specimen belonging to Dr. Hill, which Prof. Nicholson figured and described.

So far, then, as the longitudinal striæ are concerned, they are common to both the *Conchicolites corrugatus*, and *Conchicolites* (*Ortonia*) *conica*, though the longitudinal furrows may be the most distinct in the latter. No difference, either, can be determined in their social habits, for they are both found in clusters, and though the *C. conica* is sometimes found alone, and the *C. corrugatus* has not been identified in that position, it does not follow, from any kind of logic, that it may not yet be thus identified.

They differ so little from each other that the only distinction worthy of a specific name is founded in their method of attachment. *Conchicolites corrugatus* seem to attach at the point to some object, and they also seem to adhere together all along the tube. They are found sometimes radiating from a point, and so densely crowded together that the upper surface, presenting the openings of the tubes, has an appearance somewhat like the cells of a coral. The *Conchicolites conica* seems to adhere to each other when piled one on top of the other, as is often the case, and to adhere to whatever object they attach to throughout the whole length. I have a cluster of six having their points together, and attached throughout their whole length, which make a conical shaped mass, but do not show how or to what they were attached. The cluster was found detached, as it is now.

The two species, therefore, are not generically separated, and as *Conchicolites* is the oldest genus, the *Ortonia conica* will fall into that genus, and be called *Conchicolites conica*, unless it is really the *Tentaculites flexuosa* of Hall, which I am inclined to believe, in which case it will be known as *Conchicolites flexuosa*. *Ortonia minor*, for the same reason, will be *Conchicolites minor*.

I do not pretend to be able to throw any light upon the question of their affinities with *Serpulæ*, or their classification as *Tubicolar Annelides*, and do not deny that it is possible that there are generic distinctions between them, but simply present the above facts, with the expression of an opinion that the differences pointed out and observed do not more than distinguish species.

Megambonia Jamesi.—(Meek.)

By an inadvertence of some kind *Megambonia Jamesi* is twice called *M. Cincinnatiensis*, on page 138 of the "Ohio Paleontology." This book is a valuable contribution to science, but a little care would have made it more valuable, by preventing some of the typographical and other mistakes that occur in it.

Strophomena fracta.—(Meek.)—The *Strophomena fracta* (Meek), page 91 of the "Ohio Paleontology," would seem to be a good species, and not a mere variety of *S. alternata*, because it differs, both externally and internally, from the latter, and there are no shells marking the gradations from one to the other that distinguish mere varieties, so far as known.

Heterocrinus simplex var. grandis.—(Meek.)—The crinoid base, on plate 2, fig. 6 (*d, e, f*), of the "Ohio Paleontology," is much more likely to be the base of a *Heterocrinus simplex var. grandis* than the base of an *Anomalocrinus incurvus*, as suggested.

Genus *Ambonychia* (Hall), 1847. [Pal. of N. Y., vol. i, p. 163.]

[Greek *ambon*, the boss of a shield, and *onyx*, a claw or talon; in allusion to the rounded, incurved umbones in the typical species.]

"Equivalve, inequilateral, compressed, alate or subalate posteriorly, obtuse and abruptly declining, or curving downward on the anterior margin. General form somewhat obliquely ovate, gibbous or inflated toward the umbones and on the center of the shell; cardinal margin very oblique, or approaching a line parallel to the direction of the umbones, which are often incurved at the extremity, and equal or project beyond the line of the anterior extremity; surface marked by more or less prominent concentric striæ—strong undulations or fine radiating striæ. Muscular impressions large: one in each valve."

[Note to the genus *Ambonychia*, with cuts from "Pal. of N. Y.," vol. 3, p. 269–523.]

"Figure 5 shows the hinge line, the cardinal teeth *t*, and the lateral teeth *tt*. On the anterior side the margin of the shell is sinuate, for the passage of the byssus *h*. The latter character is likewise more distinctly shown in figure 6, which is an anterior view of the right valve."

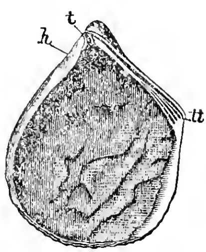

Fig. 5.

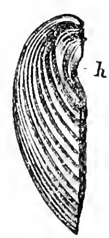

Fig. 6.

"There are two strong teeth beneath the beak, while at the posterior extremity of the hinge line there are three lateral, elongate and slightly curving teeth, the hinge area being striated longitudinally." The *A. radiata* has a single large and nearly central muscular impression.

Fossils of the genus *Ambonychia* are found throughout the Cincinnati group, from low water-mark at Cincinnati, to the Upper Silurian in Ohio, and at Versailles and Richmond, Indiana. Whether any one species extends through this great depth or not is at least extremely doubtful. The form most common at Cincinnati, within two hundred feet of low water-mark, appears to agree with Hall's Trenton limestone species, *A. bellistriata*, which he described as follows:

"Obliquely subovoid, ventricose, very inequilateral, height much greater than the length; umbones very ventricose, and extended into long and incurved beaks, which bend forward at their extremities; anterior margin not alated, or extending beyond the beaks; posterior side compressed, subalate; base regularly rounded; cardinal line short, very oblique to the umbones; surface marked by fine radiating striæ, with a few elevated concentric lines of growth."

"This beautiful fossil shell is readily distinguished by its external form and markings. The umbones are extended into long incurved beaks, which are very ventricose, and rise abruptly from the shell toward the summit; the central and lower part of the shell is regularly convex, becoming more compressed toward the margin. The anterior side extends almost in a right line from the beaks toward the base." [Pal. of N. Y., vol. i., p. 163.]

I have the hinge line of this species from the excavation for Columbia avenue, at an elevation of about 150 feet above low water-mark. It exactly agrees with figure 5 above.

The form most common about the stone quarries at the top of the hills back of Cincinnati has been by Prof. Hall himself referred to his species from the Hudson river group, *A. radiata*. This is the most common *Ambonychia* in the Cincinnati group, though it is very rare to find anything more than a mere cast of the fossil. It prevails higher up in the rocks quite as abundantly as it does at Cincinnati, and in a condition quite as unsatisfactory and imperfect. It is described as follows:

"Equivalve, obliquely obovate, extending into acute curving beaks; anterior slope nearly straight above and rounded below; posterior slope oblique, scarcely alate; surface marked by twenty-five to forty strong, simple radii, which are crossed by fine, concentric striæ; radii flattened upon the top; the intermediate spaces are regularly concave grooves, narrower than the radii, and marked by the concentric striæ." [Pal. of N. Y., vol. i., p. 292.]

Another form, the *A. Costata*, is described in the "Paleontology of Ohio," vol. i, p. 130, from a point 350 feet above low water-mark, at Cincinnati. It is distinguished from the *A. radiata* "by its small number and more widely separated costæ, and rather compressed, narrow form," and "in having its costæ separated by flat interspaces, instead of regularly concave grooves, narrower than the radii."

These are all the species that have been clearly identified in the Cincinnati Group, that belong to this genus, unless it should be the *A. Casei*, which I believe to belong to another genus (*Anomalodonta*). There are, however, other species, unless the *A. radiata* had many varieties, for there are at Richmond, Indiana, two types of casts, and many variations from these types; and there are about Cincinnati casts that vary in form and size from those that can be clearly identified with the known species. And the same may be said of other localities within the Cincinnati Group. A good shell, showing the exterior, may be found, if looked for, that will send a flood of light over many of these unsatisfactory and undistinguished casts. Indeed, it is likely that there is not, to-day, a single fossil genus, in the Cincinnati Group, but that will have new species placed under it by future discoveries, notwithstanding that the hills of Cincinnati have been hunted by collectors for more than forty years, and the prevailing impression that there is nothing new under the sun.

Genus *Anomalodonta.*—(S. A. Miller.)

Character: Equivalve, inequilateral, byssal sinus on the anterior side, immediately below the beak, cardinal tooth or elevation beneath the umbone sloping posteriorly from the beak. Cartilage grooves running from the cardinal tooth beneath the beak to the termination of the wing posteriorly, and varying in number in the same species with the size and age of the shell, and having the same number of cartilage grooves on the anterior side of the cardinal tooth, that run together as they pass into the byssal sinus, immediately beneath the beak, which vary in number under the same circumstances. Adductor muscular impression on the anterior side, below the byssal sinus. The other muscular impression probably placed posteriorly on the wing.

This genus will include the *Ambonychia alata* (Meek). "Ohio Pal.," vol. i, p. 131. Mr. James has a specimen of this species, which shows enough of the hinge line to leave no doubt that it is not an *Ambonychia*, and that it must be placed in this genus. And it will probably include the *Megaptera casei* (Meek and Worthen). "Ill. Geo. Sur." vol. iii., p. 337, and "Ohio Pal.," vol. i., p. 132, because the general appearance, and the apparent thickening of the shell on the posterior wing, renders it most likely that it does not possess the internal markings of the genus *Ambonychia*, and quite probable that it does possess the hinge line of this genus.

The *Anomalodonta alata* and *Megaptera Casei* are both found in the upper part of the Cincinnati Group, in strata about the equivalent of the Versailles rocks, where the *Anomalodonta gigantea* is found. The *Megaptera Casei* being found at Richmond, Indiana, and the *Anomalodonta alata* in the vicinity of Morrow, Ohio.

Anomalodonta gigantea.—(S. A. Miller.)

Shell equivalve, inequilateral, alate posteriorly and compressed, more convex toward the umbones and anterior side, anterior side abruptly declining, beaks rather sharp and slightly incurved. Surface marked by 30 to 40 strong radii, same width as intermediate spaces, which are concave grooves marked with concentric striæ, giving much the same

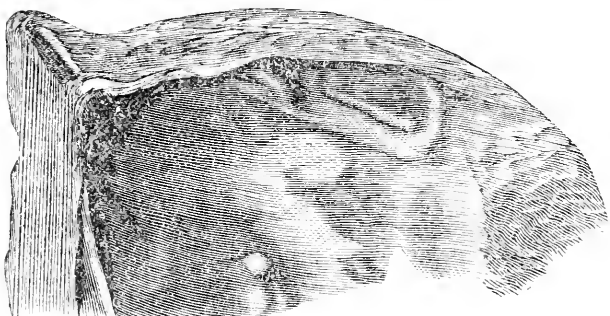

Fig. 7. *A. gigantea.* Left valve showing hinge line and muscular impression.

external appearance as those of an *Ambonychia radiata.* Shell marked exteriorly, toward the margin, with lines of growth and concentric striæ, which cross the radii, rendering it likely that concentric striæ

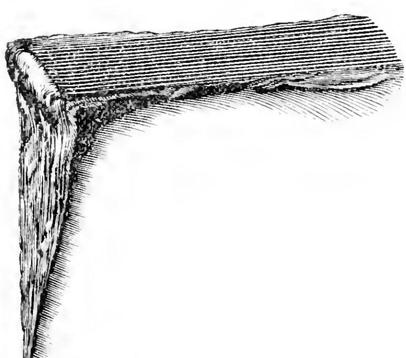

Fig. 8. *A. gigantea.* Right valve, hinge line.

crossed the radii over the whole surface of the shell, though they appear now to be smooth. Byssal sinus immediately below the beak anteriorly, about $\frac{1}{4}$ of an inch in diameter in a large specimen. Height of the shell from 2 to 4 inches, greatest breadth about $\frac{1}{5}$ less. Shell quite thick about the umbones and wing, but thinner toward the base. Large cardinal tooth or elevation beneath the umbones, and sloping posteriorly from the beak. The cardinal elevation on the left valve

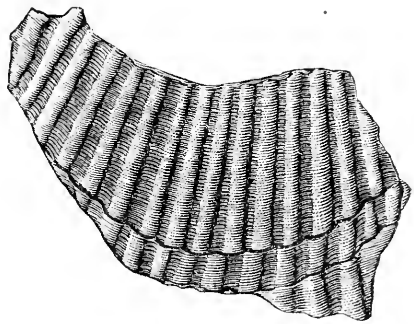

Fig. 9. *A. gigantea.* External surface.

having a depression to receive a corresponding elevation, though slight, on the right valve. From the cardinal tooth there are from 4 to 18 lateral cartilage grooves extending posteriorly to the end of the wing, and terminating with the shell, and there are the same number of cartilage grooves on the anterior side of the cardinal tooth that immediately run together as they pass into the byssal sinus. The cartilage grooves vary in number with the age and size of the shell. The shell is thickened on the anterior side, and appears to show lines of growth passing through the sinus to its base. A large muscular impression is found near the anterior margin, half way from the sinus to the base of the shell, and there are appearances that indicate another muscular impression on the posterior wing of the shell, near its termination. Greatest depth of a valve in a large specimen, $\frac{1}{2}$ an inch.

This is the largest bivalve yet known in the Cincinnati Group. It may readily be distinguished from the *Anomalodonta alata* by the surface markings, though the general outline form of the two shells are nearly the same.

I found this species near Versailles, Indiana, about 40 miles west of Cincinnati, and about 300 feet below the Upper Silurian rocks; and I also found what I believe to be a cast of the same at Richmond, Indiana. I do not know that it can be found elsewhere, but the probabilities are that it can be found in the upper part of the Cincinnati Group, from Madison to Richmond, and at other places.

Descriptions of New Species of Brachiopoda, from the Lower Silurian Rocks—Cincinnati Group; by U. P. James.

Orthis cyclus.—(James.)

[*Cyclus*, in allusion to the circular form of the shell.]

Shell small, much compressed, sub-circular, broader than long; length, about six sevenths of the breadth; cardinal line about two thirds as long as the greatest breadth of the shell; margins rounding from the extremities of the cardinal line to the front, presenting an outline of more than two thirds of a circle; slightly sinuous in the front; valves very thin and closely drawn together for more than two thirds the surface area.

Dorsal valve convex above the middle, but nearly flat toward the free margins, with a slight mesial sinus from near the beak extending toward the front. Beak very small, slightly projecting, not incurved; hinge line straight and narrow, short; foramen very small, filled by the cardinal process of the other valve. Interior shallow, with quite a strong mesial ridge extending, in some cases, to the front, in others, flattening out before reaching the front margin. No definite muscular impressions below the teeth; internal surface showing the striæ of the exterior of the shell distinctly.

Ventral valve nearly flat, more than two thirds of the surface area, convex on the umbone, quite abrupt, with a slight mesial ridge flattening out toward the front margin. Beak projecting beyond the dorsal valve, incurved; area much higher than the dorsal valve, sloping rapidly toward the extremities of the hinge line. Interior: teeth prominent; lateral muscular cavities, under the hinge line, at the sides of the teeth, deep; muscular scars, none; quite a deep mesial sinus extending from the cardinal process about half way to the front margin. External striæ distinctly shown through the shell, as in the dorsal valve.

Surface of valves covered with prominent, rather coarse radiating striæ, which bifurcate before reaching the free margins, and are strongly curved back along the hinge line. Numerous very fine concentric lines between and across the striæ; with, occasionally, strong imbricating lines of growth in some specimens.

Length of mature, rather large, individuals, 0.42 inch; breadth, 0.50 inch.

This shell resembles *O. emacerata*, Hall, but differs in the coarser striæ and internal markings, and is scarcely half the size of mature specimens of that species. It also bears some resemblance to *O. mul-*

tisecta, James, but the ventral valve of that species is not compressed, is decidedly convex from the free margins, and the dorsal valve concave, and it is a more robust shell than this, the radiating striæ finer, and internal markings quite different.

Position and locality: Cincinnati Group, about 75 feet above low water-mark of the river Ohio, at Cincinnati.

Orthis (Platystrophia) cypha.—(JAMES.)

[*Cypha*, in allusion to the remarkable convexity of the dorsal valve.]

Shell medium size; extremely gibbous; hinge line forming spine-like projections, being over two thirds longer than the greatest breadth of the shell below; shell broader than long; convexity equaling the body below the hinge extensions; cardinal area narrow, and finely striated at right angles with the length. Dorsal valve, remarkably elevated mesial fold, with slopes commencing a little below the beak, and extending to the front, at an angle of about 80 degrees to the main body of the shell, where they turn at nearly right angles and continue to the free margins; beak incurved, not elevated above the other valve; the mesial fold consists of two costæ. Ventral valve, beak incurved, not elevated, nearly in contact with the other valve. Sinus very profound, extending to the front, which is bent over to nearly half the thickness of the shell beyond the cardinal line of the dorsal valve; one strong elevated plication in the center of the sinus, and an obscure rudimentary one on each side; lateral slopes concave.

Twenty-two to twenty-six angular costæ on each valve, about eight of which commence on the cardinal line, and do not extend to the beak.

The line of junction of the two valves is nearly flat, or slightly rounded, and has a remarkably zig-zag appearance, forming, where the sinus and mesial fold join, the letter W.

Interior unknown.

Width along the cardinal line one and a half inches, half way below the hinge line less than one inch; length three quarters of an inch.

This shell resembles somewhat some of the larger specimens of *O. crassa*, Meek, but it is more gibbous, has a more profound and lengthy sinus, greater length of hinge line, and finer and more numerous costæ.

Position and locality: Cincinnati Group, Warren county, Ohio.

Orthis (Platystrophia) crassa.—(MEEK.)

In the Ohio Geological Survey, part ii., vol. i., Paleontology, page

117, plate 10, fig. 3, Mr. Meek describes a shell as *Orthis dentata*, Pander, and expressess doubts as to its being the form intended by Pander for that species. The specimens were wrongly put up for Mr. Meek. Pander's *O. dentata* not being sent.

I now propose the above name for the shell described by Mr. Meek. After comparing with *O. laticostata*, James, he says:

"Its hinge line, generally, about equals the greatest breadth of the valves, but may be a little less, or a little greater, than the breadth. Its lateral slopes are always abrupt, and much less compressed than *O. laticostata*; but, like that variety, its mesial sinus is large, and very profound, with angular margins, and its mesial fold strongly elevated. In old individuals, the valves become often remarkably gibbous, the convexity exceeding the length and nearly equaling the breadth, being much increased by the prominence of the mesial fold, and the elevation of the plications forming the margins of the sinus. It differs from *O. laticostata* in generally having but a single strong plication in the sinus, and only two on the mesial fold: though we sometimes see an individual with the commencement of a second smaller plication occupying one of the slopes of the sinus on one side of the middle one, and very rarely one with a third one on the other side. Where rudimentary plications exist in the sinus, they usually give origin to corresponding, partly developed plications on the slopes of the mesial fold of the other valve. All the plications are simple, and excepting the rudimentary ones mentioned, quite coarse, prominent and angular; the number on each lateral slope being constantly five or six."

I will add, that different individuals of this species vary considerably, some of the smaller ones being less than half an inch long and five-eighths inch wide: the larger ones over an inch long and one and a quarter inch wide. Some specimens, the cardinal line is not over half the greatest width of the shell; others, it is more than the greatest width below; but, taking a number of individuals, the difference from one to the other is found to be very gradual.

Position and locality: Cincinnati Group, between 300 and 400 feet above low water-mark of the Ohio River, at Cincinnati.

Orthis (?) Morrowensis.—(James.)

Shell oval, broader than long, cardinal area narrow, and about one third of the greatest width of the shell; foramen narrow, extending to the beak; dorsal valve convex, sloping rather abruptly from a mesial elevation to the free margins; mesial elevation extending to the front; beak incurved; ventral valve convex, with a triangular mesial sinus, narrow at the beak and spreading out rapidly to the front; front slightly sinus; surface marked by about seventeen angular costæ on each valve, which are simple except in the sinus where but one extends to the beak; two others commence a little below; and on the mesial elevation of the other valve, where two bifurcate near the beak and again near the front. Interior unknown.

Length a little less than $\frac{5}{16}$ths of an inch; breadth, a little over $\frac{6}{16}$ths.

This shell bears some resemblance, in the beak and cardinal area, to *O.* (?) *ella*. Hall, but very slight in other respects. I have seen only one specimen, but it differs so much from any other species that there seems no doubt of its being distinct.

Position and locality: Cincinnati Group, Warren county, Ohio.

Our Fresh-water Entomostraca; by V. T. CHAMBERS, ESQ., of Covington, Kentucky.

Life everywhere! What myriads of living forms surround us in earth, air, water, everywhere—except in the fire; and if the experiments of Dr. Bastian and other abiogenesists are reliable, then their opponents are driven to the conclusion that there are multitudes of living germs which can endure, without losing their vitality, degrees of heat greater than are sufficient to burn many other substances.

But it is not of these minute and elementary forms of life, only discernible under the higher powers of the microscope, that I propose now to write; nor yet even of those higher forms of infusoria, as *Paramecium, Stentor, etc.*, which swarm in every drop of stagnant water, and with which all microscopists are familiar.

Nevertheless, though much higher in the scale of organization, and much larger than these forms, the little entomostraca require the aid of the microscope for their elucidation, and even of its highest powers for the study of their anatomy; and though less numerous than *infusoria*, yet they swarm in incredible numbers throughout the summer in the waters of our ponds and streams, and when the droughts of summer have entirely evaporated the water, they and their eggs may still be found in the moist earth, into which they likewise retreat from the cold of winter.

But what are the entomostraca? They belong to the anulose subkingdom, together with insects, shellfish, worms, etc., and to the class Crustacea, containing lobsters, crayfish, etc., forming one division of that class. Dr. Baird, in his "Natural History of the British Entomostraca," published by the Ray Society, says they "may be characterized by their being all aquatic; by their being covered with a shell or carapace, which is of a horny or coriaceous texture, and formed of one or two pieces, in some approaching in appearance to a bivalve shell, in others being in the form of a buckler, which completely, or in great part, envelopes the body of the animal; by their having branchiæ attached to the feet, or organs of mastication; by their feet being jointed, and all more or less ciliated; and by their undergoing a metamorphosis, or regular change of shell as they grow, in some amounting to a species of transformation."

Like other animals, they have been subdivided by naturalists into families, genera, and species, according to their structural differences, size, and differences in ornamentation.

One division, the *Branchiopoda*, of Dr. Baird, is divided by him into two orders, the *Phillopoda* and *Cladocera.* Each of these orders contain several genera; but as we propose to give account only of species which we have met with in this locality, we only refer to the two *Phillopoda* genera, *Branchippus* and *Estheria*, neither of which is mentioned by Dr. Baird, though *Branchippus* is very nearly allied to the beautiful little fairy shrimp, the *Chirocephalus diaphanous*, of that author. We have met with but a single species of *Branchippus*, the *B. vernalis*, Verrill, and that only in a single pool. In the "bottom" land, known as Taylor's flats, and lying just south of Covington, on the stream euphoniously designated as "Bank Lick Creek," are numerous ponds, abounding in all sorts of pond life; but in only one of these, and that one a mere puddle, but a few feet in diameter, and entirely dry throughout the summer, have we met with *B. vernalis.*

In this little pool it may be taken in great numbers in April. It is something over half an inch long, white and translucent, with the post abdomen or tail stained rust red, and the apical portion of the *Ontennæ* of the same hue. The eyes are borne on short stalks above the head, and it has thirteen pairs of branchiferous feet, which are constantly in motion, aiding it in locomotion as well as affording it respiration. Its motion is exceedingly graceful, and when a number of these delicate, fragile, little creatures are placed in a glass of clear water they afford a pretty and interesting sight swimming, or rather easily floating, head upward, through the water. Possibly this species may prove to be distinct from *B. vernalis*, Verrill. The allied *Chirocephalus diaphanous* has not been discovered in this country, but is common in England and on the European continent. Prof. Verrill (Sill. Am. Jour., vol. lviii., p. 244) separates from *Branchippus* proper two other closely allied genera, under the names *Branchinecta*, of which he describes two species from Labrador and Greenland, and *Heterobranchippus*. *Heterobranchippus* was subsequently recognized as a *Streptocephalus*, and *B. vernalis* made the type of a new genus, *Enbranchippus*. *Artemia*, another genus of the same family, *Artemiadæ*, Jones, *Branchipodidæ*, Baird), is found in brine pits, and Prof. Verrill (*loc cit*) describes a species from the Great Salt Lake. *Nebalia* is the only extant genus of the allied family *Nebaliadæ*, of which two genera (*Hymenocharis* and *Ceratiocaris*), are found fossil in the Silurian strata. *Apus*, of the allied family *Apodidæ*, is extant, and it, or a closely allied form, has been found fossil in the coal measures. *Entomoconchus*, also of the coal, is considered a *Phillopod* by Prof. Owens (Paleontology, p. 42); but Prof. Rupert Jones, from its resemblance to the recent *Heterodesmus* (Brady), places it among the *Halocypridæ*. *Dithyrocaris* is a fossil genus of the *Apodidæ*. *Limnadiadæ* and *Limnetis* are recent genera of the family *Limnadiadæ*, which contains also *Estheria*, recent and fossil, extending back to the Devonian series. I have met in this locality with a single species of *Estheria*, undescribed, I think; but it may be one of two species recently described by Dr. Packard.

Six species of this genus, from North Amèrica, have been described. When found at all they usually occur in great numbers, and some of my specimens were given to me by a gentleman who informed me that they were taken in a wagon track or small puddle, where they were so abundant that a dip of the hand would take half a dozen. But the single specimen taken by me was under very different circumstances. In a pond, which, because of its convenience and the multitude and variety of microscopic forms it affords, has been my favorite collecting ground, I one day dipped up a specimen in an iron spoon. It surprised me greatly, because I had dipped and dredged in that pond so often and so long that I thought I knew everything it could afford, and had never met with an *Estheria*; and the most diligent search has failed to reward me with a second specimen. The body and branchiferous feet remind one somewhat of *Branchippus*, but the resemblance is very general. The eyes are not stalked, and, in fact, scarcely deserve to be called eyes, as they are not even crystaline, but are simply two small pigment spots confluent on the median line of the forehead. The head is produced beneath into a short beak, as in the family *Daphniadæ*. The larger antennæ are furćate, many-jointed, and armed with long cilia, one branch being shorter than the other; the smaller antennæ are very short; there is no long post abdomen or tail like that of *Branchippus*, but the post abdomen is short, and ends in two pairs of spines, one above the other, and each curving upward; and along the back, toward the tail, is a row of small spinous projections, reminding one of the vertebrate *apophyses*, and the branchiferous feet are more numerous than in *Branchippus*. But the most marked difference is that *Estheria* inhabits a small bivalve shell, resembling those of some molluscs; and while dredging for another specimen of my *Estheria*, I found a single specimen of a small mussel, so like it in size and form that I was not convinced of the difference until I took it in my fingers. But the mussel shell is hard and calcareous, while that of the *Estheria* is thin, flexible and chitchitnous. It is attached to the body of the animal just behind its head, and is composed of a series of concentric laminæ or rings, which Dr. Baird supposed to represent each an annual growth. But his conclusion may perhaps be doubted. In the specimen taken by me I counted thirty-five such rings, and it is almost incredible that this defenseless little creature had successfully weathered all the vicissitudes of pond-life for thirty-five years. *Estheria* swims by jerking itself along through the water with its long antennæ, aided by motions of the abdomen, making, as it were, a series of successive jumps, and resembling rather the jerking motions of *Daphnia* than the gentle and graceful undulations of *Branchippus*. The young, also, at one stage, bear some resemblance to some adult *Daphniæ*, as, however, those of *Branchippus* and *Chirocephalus* likewise do; the resemblance, however, is not very close. The specimen taken by me carried a saddle of eggs across the back, just behind the point of attachment to the shell. The eggs were very numerous, some hundreds I should say, though I did not count them, very small, globular, and pale yellow. The specimen died from injury received in handling it, and only four of the eggs hatched, and all of these died before the third month. I regretted this the more, because if its development has been heretofore observed, I am not aware of it, and I was anxious to trace its course. All the *Phillopoda* undergo metamorphosis, and *Estheria* is no exception to the rule. In its first or *Nauplius* stage, just emerged from the egg, it closely resembles Dr. Baird's figure (Nat. His. Brit. Ent., plate 5) of *Chirocephalus diaphanous* at the same age, but it is even a more simple and elementary form (approaching somewhat to the young of *Cyclops*). The projecting antennæ of Dr. Baird's figures are represented by Setæ only; the posterior pair of limbs is not so much developed, and the thorax is less distinct from the abdomen, which is notched at the apex. It was first observed at 3 p. m., and at 9 p. m. the only change observed was that the limbs were more distinct, and had a more definite outline; the thorax was more distinct from the abdomen, the apex of which was distinctly furcate. At 9 a. m. next day the projecting points at the apex of the abdomen (post abdomen) were much better developed, the limbs, thorax and abdomen were very distinct from each other; the branchiæ were rudimentary, and a shield (the beginning of the shell) covered the head and thorax above, and a similar, but smaller shield, attached only by its anterior margin, covered the ventral surface of the thorax.

The next family in the arrangement of Prof. Rupert Jones, which I have followed, is the *Leperditiadæ*, all the genera of which are fossil. *Entomis Beyrichia Primitia* and *Leperditia* are found on the Silurian rocks. *Beyrichia*, indeed, is not very uncommon in the rocks of the "Cincinnati uplift." *Kirkbya* is found in the carboniferous period. The *Trilobites* of our Silurian rocks are regarded as an extinct family of *Phillopada*. Like many of the above mentioned genera they were salt water species. Various new species of *Apus, Streptocephalus Limnadia, Limneti,* and *Estherid* are described by Dr. Packard in Silliman's Journal for 1871, p. 109, and in the Am. Mag. Nat. His., series 4, vol. 8.

Notes on Botany; by PROF. JOHN HUSSEY, PH. D.

TRICHOMANES RADICANS.—This fern is now fairly entitled to a place in the flora of the northern United States. The discovery is due to the observing habits of Dr. H. H. Hill, of Cincinnati, who, in company with the late Dr. McConnell, visited the caves in Carter county, Kentucky, during the summer of 1871. During an exploration in the vicinity of the caves, Dr. Hill, on the lookout for objects of natural history, made the discovery of this fern. Not knowing the name of the plant, he distributed some specimens at Cincinnati. Some fronds were sent to correspondents, some of whom, supposing they were the subjects of a trick, and that the specimens came from a Cincinnati hothouse, did not deign to return a civil answer. It seemed incredible that the *Trichomanes radicans* should be obtained in Northeastern Kentucky. During the winter of 1872-3, Dr. Hill gave me specimens which I decided to be *Trichomanes radicans*. I then determined to visit the locality, and, accordingly, in the month of August, 1873, embraced Carter county, Kentucky, in an extensive collecting tour which I was making. The caves are in limestone, which is cut and exposed by deep drainage valleys, but the caps of the cliffs are composed of sandstone. Had I not secured the services of a guide, who had been with Dr. Hill, it is not at all probable that I should ever have found the few square feet on which the plant is growing. On the under side of the overhanging sand-rock, perhaps twenty feet from the exposed face, which looks to the east, where the upper and lower beds are so near together that one must literally crawl to reach some portions of the mass of fern, I found a space of about one rod in length by two or three yards in width, covered with a completely interlaced web of the radiating stems of the plant I was seeking. The pendent fronds were green and fresh, although the face of the sand-rock was scarcely moist, this being the dry season. The disconnected sandstone ridge, cut up into a labyrinthine maze by the drainage, depends solely for moisture upon the natural rain-fall. It is no dripping rock, such as the *Tricomanes radicans* usually flourishes upon. This may account for the rather inferior size of the fronds from this locality. I brought away many specimens, and have succeeded in growing the fern in a pot, under glass, in my house.

I found in the same neighborhood *Asplenium trichomanes*, *A. pinnatifidum*, *A. ebeneum*, *A. montanum*, and *A. ruta-muraria*; *Camptosorus rhyzophyllus*; *Pellæ atropurpurea*, and many others. The *Abies canadensis* grows to a large size, with long, straight trunks, in the valleys, and the *Taxus baccata var. canadensis* is quite common.

Polypodium incanum.—This fern is found growing on trees, on Brush Creek, Adams county, Ohio, and also at Rock Springs, about twelve miles from Louisville, Kentucky. I have never seen any mention of it as being found on the lower Wabash, but, from the nature of the flora of that river, I think it may be confidently looked for there.

Asplenium montanum.—Very fine specimens of this fern were gathered by me near the entrance to Mammoth Cave, in Kentucky, in August of last year. They were growing on limestone, and the fronds measured from nine to ten inches in length. Many of the fronds are bifurcated at some point between the middle of the frond and the apex, or sometimes even lower down, giving the appearance of two fronds on one stipe.

Asplenium pinnatifidum.—I found in connection with the last a variety of *Asplenium pinnatifidum*, which I deem worthy of mention. These are some of the points in which it differs from the more usual form: It is pinnate, the pinnæ, as in many ferns, becoming more confluent as they approach the apex. The apex, in my specimens, is less prolonged, but is fertile throughout its entire length, as in ordinary typical specimens. The divisions of the more usual fern touch, or, more generally, overlap. The pinnæ of my specimens are distant, the interval between the lower pinnæ being equal to the width of the pinnæ themselves. The lower pinnæ obscurely lobed and denticulate. The stipe is not so broad, and is brownish black at base, sometimes two thirds of the length. I did not see any other form in the vicinity of Mammoth Cave, nor did I see the *Comptosorus rhyzophyllus*, though I regard it quite probable it occurs there. If it deserves to be called a variety, I suggest the name *Asplenium pinnatifidum var. pinnatum.*

Botrychium lunarioides var. dissectum.—For several seasons I have found, early in the spring, now and then, a stray plant of this species. The sterile frond only remained, and it was thick and hardy in aspect, and dull in color. These plants had evidently wintered over, and may be regarded as hardy in this latitude. They are low, and easily covered with leaves, and readily escape observation. This fall, in October, I took up and potted a fine specimen of the *var. dissectum.* About the middle of December the fertile frond withered, and I removed it. The sterile frond, on the other hand, has remained unchanged until this time (January 16), and I do not doubt that it is hardy. I therefore conclude that the sterile frond of *Botrychium lunarioides* is hardy. Like the *Aspleneum ruta-muravia,* which is hardy, the sterile frond of *B. lunarioides* will perish before or at the time the new frond springs up.

OPHIOGLOSSUM VULGATUM.—On removing some roots of this fern from the ground, last fall, into pots, I observed that the new frond had already started, and was about one half inch in length. They have remained, up to this date, just as they were when they were removed from the ground. I suppose this is a habit of the species.

THE BOTANICAL DIRECTORY FOR NORTH AMERICA AND THE WEST INDIES.—This is the title of a publication giving the names of all the working botanists in the territory embraced. It has just been issued as part of one of the numbers of the Bulletin of the Torrey Botanical Society of New York City. It gives, first, the names and the specialty, if any, of the botanists known to the editor, with the name of the State appended in which he resides; then follows another list of the names, under the States, with full postoffice address.

LIST OF TREES AND SHRUBS OF OHIO, in the "Report of the Ohio Agricultural Society for the year 1872."—This list, made out by Prof. Hussey, is accompanied by an address by the same person on our Forest Trees, their Distribution, Age, etc. The idea is set forth and illustrated in the address, that the distribution of our trees depends, in great measure, upon such circumstances as favor the germination of the seed and the growth of the young plant for one or more seasons. Such trees as have a vigorous growth in their early stages are more widely disseminated. Those that are less so, but only flourish when young in the shade of other trees, or in favorable seasons, are not so widely disseminated. Uniformity of species is regarded as indicating a comparatively recent forest; a great variety, a more ancient forest. A practical inference is that the most of our forest trees will flourish in places where they are not now found, as in prairies and the western plains, if the young trees are cultivated a few years from the seed. The tree will grow under cultivation where the seed will not germinate, and if it germinates, where it will not grow without care at first. We want more exact information in regard to the lines which bound species. The publication of correct local lists of plants is greatly desired by botanists.

From *Die Silurische Fauna des Westlichen Tennessee.* By Dr. FERDINAND RŒMER. [Translated by THOMAS VICKERS, for this Journal.]

I. *Spongiæ*.—The occurrence of *Spongiæ* in the older formations, down as far as and including the *Zechstein*, is very rare, when we compare it with the frequency of these bodies in certain divisions of the Jura and Chalk formations, and in the seas of the present epoch. From the *Zechstein* we know, through King, of a few ill shaped and badly preserved forms, concerning which, in part at least, it is still doubtful whether they belong to the *Spongiæ*. In the carboniferous group no remains have hitherto been found which can with certainty be said to belong to this class. In the Devonian rocks, their appearance, aside from a few altogether doubtful substances, is limited to a small species, described by the brothers Sandberger as *Scyphia constricta*, occurring in the limestone of Vilmar; its state of preservation, however, like that of all the fossils in the above locality, is so unfavorable, that in this case, also, there are still doubts as to its really belonging to the sponges. It is only the Silurian series that can show any considerable number of undoubted *Spongia*. Hitherto, it is true, they have been observed only in isolated places. Several larger species are found in an accumulation of Silurian diluvial bowlders, near Sadewitz, not far from Oels, in Silesia, of which Oswald has given a description, and for some of which he has created the genus *Aulocopium*. More numerous and better preserved are the species of our fauna from Tennessee, which I am about to describe. That they belong to the *Spongiæ* is just as certain as the Silurian age of the strata in which they are embedded. They are petrified, as most of the sponges of the Chalk and Jura formations are, and exhibit in their interior a texture altogether analogous to the later sponges, perforated by canals, and the interstices filled with countless little spicula, grouped in the form of stars. They lie in the same calcareous strata with numerous undoubted Silurian crustacea, crinoids, and zoophytes, and are frequently found embedded in the same piece of rock with the latter. The frequency of the individuals is so great that they form an essential part of the fauna. It is surprising that they are not found in the precisely contemporaneous strata of the State of New York (Niagara Group of the New York State geologists), though numerous fossil species are identical in the two formations, nor in the contemporaneous Wenlock limestone of England. On the other hand, however, from the limestone of the Island of Gotland, which otherwise so nearly resembles that of Wenlock, we have the *Astylospongia præmorsa*, and another species, very numerous, but still undescribed, which agrees with a species of Sadewitz. In general, all the Silurian sponges that have yet been found seem to belong to the geognostic level of the limestone of the Island of Gothland. Up to this time no sponges, that can with certainty be determined, have been found in the lower division of the Silurian Group.

That, in spite of the calcareous nature of the strata, the petrified mass is always siliceous can evidently be not accidental, but certainly depends upon the essentially siliceous constitution of the corporeal substance of the animal during life. [The substance of living sponges is also in great part siliceous. I have received through Prof. Steenstrup, in Copenhagen, pieces of the well known, large, goblet-formed *spongiæ vesparia*, Lam., in which all organic substance has been destroyed by means of white heat. The form and structure of the sponge has remained entirely unchanged, which can only be explained by the fact, that, according to an analysis by Forchammer, the species contains in its fresh condition seventy-five per cent. of silica.] By means of this physical constitution other silica, dissolved in water, has been attracted in the process of petrifaction, and the hollow space of the texture filled up by it just as during the life of the animal; the calcareous nature of the shell and spines of the *Echinidæ* causes the compact sparry calcareous constitution of the fossil *Echinidæ*. It is certain that between the living and the fossil sponges there is no such important and thoroughgoing difference in the compactness of the texture, as D'Orbigny (Cours élément de Pal. et Geol., 209), and after him Pictet (Traite de Paleontol., ed. 2, tom. iv., 530), assumes, when they found upon it a separation of the *spongiæ* into two great divisions (Amorphozoaires à squelette cornë und Amorphozoaires á squelette testacé).

A highly remarkable peculiarity of the sponges here to be described is that they are wanting in any sort of epitheca. All sponges in existing seas adhere to the bottom, either directly, by the lower surface of the body itself, or by means of a pedicle, into which the body narrows itself at the end. [Only the *Tethya lincurium*, Lam., and, as Sars has told me, a small living sponge, growing on the northern coast of Norway, appears to form an exception among living sponges, being free, and yet it remains to be determined whether they are always and in all stages of their development free.] All well preserved sponges of the Chalk and Jura formations exhibit an epitheca of greater or less size and distinctness. The deviation from this rule in the Silurian sponges is therefore altogether unexpected. Moreover, the preservation is so complete, and the number of individuals so great, that the fact has been determined with certainty. In no one of the numerous existing specimens of *Astylospongia præmorsa* (*Siphonia præmorsa*, Goldfuss) is there a trace of an epitheca to be seen, but in all of them the semi-circular under side is regularly rounded, without any interruption. So, also, the hundreds of specimens of the remarkable *Astræospongia meniscus* are on their flat underside quite smooth, with no scar or projection whatever which could be regarded as an epitheca. All these bodies must have lived free at the bottom of the sea, with the exception, perhaps, of there being partially sunk in sand or slime. All other sponges from the paleozoic strata, that have thus far been discovered, also exhibit the same peculiarity, particularly the apple-formed *Aulocopium* species, which Oswald has described from the Silurian diluvial bowlders of Sadewitz, near Oels, and a still undescribed sponge, about the size of a man's hand, of a thick disk form, notched on the edge, that is found at Sadewitz, and in the Island of Gothland. *Hence, it seems that, in general, all sponges of the first period, in striking contrast with the sponges of later formations, and of the present time, were free.* If, on the whole, in all the lower classes of animals, we regard the stationary condition as a sign of a lower grade of organization than the free condition, the above fact is all the more remarkable for the reason, that, having in view the general indisputable perfection of organisms with the rising gradation of the sedimentary rocks, we should expect just the opposite to be the case. Moreover, the regularity in form of the Silurian sponges, as more particularly manifested in the *Astylospongia præmorsa*, and *Astræospongia meniscus*, is evidently dependent on this free condition, for we know that in general, in the lower classes of animals, the freer forms have greater regularity of shape than the stationary ones, wherein the size and form of the epitheca partially determines the form of the body.

Several years ago I gave an enumeration of the sponges now to be described, in Von Leonhard's & Bronn's Jahrbuch für Mineralogie. Here the description of them is given more completely and enlarged, especially by the knowledge of the interior structure of several species.

Genus Astylospongia (Dr. Ferd. Rœmer).

This globular, or thick, disk-formed, and almost regularly circular sponge is free, not attached. The inner texture is formed by little, very regular, star-shaped bodies, which are connected with each other by their rays. Larger canals run from the center, in the form of rays, to the surface, and are crossed by concentric canals. Even during the life of the animal the body must have been of a tolerably compact nature, inasmuch as it is never found compressed. The petrifaction is always siliceous.

The typical species of this genus has been known for some time under the name *Siphonia præmorsa.* The decidedly free, not attached condition, is the principal character which separates this genus from the genuine *Siphonia* of the later formations, and justifies the creation of a separate genus. Besides, the body being composed altogether of little regular stars, connected together, is a peculiarity not found either in the genuine *Siphonia,* nor in any other sponge genus of the later formations.

The genus, with its not numerous species, appears to be limited to the upper division of the Silurian Group.

ASTYLOSPONGIA PRÆMORSA (Gold.)

Siphonia præmorsa, Goldfuss Petref. Germ., 1, 17, t. 6 f. 9 (1826).
" " Hisinger Leth. Suec., 94, t. 26 f. 7 (1837)
" " Eichwald Silur. Schichtensyst. in Esthland, 209.
" " Maximilian, Herzog von Leuchtenberg. Beschreibung einiger neuen Thierreste der Urwelt aus den Silurischen Kalkschichten von Zarskoje Selo., St. Petersburg (1824).
" " Fred. Rœmer in Leonh. u. Bronn's Jahrb. (1848, 684).
" " Ferd. Rœmer in Lethæ geognost. ed. 3, Th. ii., 154 t. 27, f. 21 (1852–1854).
" *excavata,* Goldfuss Petref. Germ. 1, 17, t. 6 f. 8 (1826).
" " Bronn. in Leth. geogn. ed. 3, Th. v., 75 (1851–1852).
" *stipitata* Hisinger Leth. Suec. 94, t. xxvi., f. 8.
Jerea excavata, D'Orbigny Prodr. de Pal. strat. ii, 286 (1850).

A free, almost globular sponge, with a truncated and disk-formed, depressed crown, and a completely rounded or somewhat truncated underside. The concave crown exhibits a number of larger openings, the mouths of perpendicular pipes. From the edge of the crown there radiate over the sides irregular and partially branching furrows. Although a proper epitheca is never observed, yet, in the specimens from Tennessee, the lower end is sometimes truncated by a small, smooth, circular surface, on which the body rests. In older specimens the furrows radiating from the crown are often much deeper and broader. The whole body is then often no longer perfectly globular, but somewhat depressed. The whole lower half of the sponge is, moreover, sometimes bordered with wart-like prominences.

Several specimens, which I caused to be cut and polished, have shown a very peculiar constitution of the inner texture of this sponge. The whole mass consists of small, very regular, star-formed bodies, with six rays, which may be seen with the unaided eye, but more distinctly with a glass, and which are so connected together that a ray from one star runs directly into the ray of the star next to it. Between the stars, which are composed of opaque siliceous matter, there remain spaces filled with a transparent, yellowish brown chalcedony. These spaces are radial and concentric canals. The little stars one is inclined to regard as spicula grouped in that form. It is only surprising that no framework corresponding to the horny skeleton of the typical sponges is visible between these stars, and that no space is left for such a framework between the thickly crowded stars. At any rate the spongy character of the body is indisputably proved by the above mentioned inner structure, even though the outward form were not sufficient proof thereof. Moreover, there are also European specimens in the diluvial bowlders of the North German plain which exhibit precisely the same interior structure, as I have convinced myself from the cut specimens in the Berlin Museum, to which Beyrich called my attention.

The geognostic position of this species, which had been observed for a long time, and in many places in Europe, was uncertain, until the discovery of it in Tennessee. It is most frequently found as loose bowlder stone in the diluvial of the North German plain, from Holland to Königsberg. The circumstance, that the other species of the genus *Siphonia*, to which it was ascribed, all, or at least the great majority, belong to the Chalk formation; further, the mode of preservation in dark, flint-like silica, which nearly corresponds to the manner of preservation of many chalk sponges; and, finally, its being found with other fossils, demonstrably belonging to destroyed Chalk deposits, made the origin in strata of the Chalk formation probable, and as a matter of fact this origin was universally accepted. Hisinger, indeed, mentioned the species of the Island of Gothland, yet, in accordance with the words "ad littoria maris Gothlandiæ rejecta," used to designate where it was found, he regarded it as bowlder stone foreign to that place. According to the Duke of Leuchtenberg it is found at Pulkowa, near Petersburg, but even he does not with certainty regard the there contiguous Silurian strata as its original place of deposit. By means of my observation of the species in contiguous Silurian strata, in the State of Tennessee, every doubt in regard to the true place of deposit of this species has been for the first time removed. The numerous specimens (26) collected there agree completely with those in Europe. Their size varies, like those of Europe, from a hazelnut to that of an apple. In the larger specimens the crown is often flattened, as if it were eaten out, apparently, in consequence of a disintegration, while the sponge was still alive. Beside the always visible central openings the almost plain surface of the crown exhibits in this case horizontal canals, radiating from the center toward the circumference.

After the Silurian strata have been determined in America to be the original place of deposit of the species, it can no longer be doubted that the specimens which occur in Europe also have their origin in these strata. All the specimens found in the diluvium of the North German plain, in so many places, certainly come from the destroyed Silurian strata of Northern Europe, and, indeed, from the Upper Silurian strata of the age of the limestone strata of the Island of Gothland, which are contemporaneous with those of Tennessee. As a matter of fact the Gothland species is frequently and manifestly found in the original place of deposit. I have seen in the Gymnasium Collection at Wisby beautiful specimens, as large as apples, and I myself picked up one from the strand at Wisby. Finally, the Berlin Museum (and this is decisive), possesses specimens from Wisby, which are still embedded in Silurian limestone. In the University Collection, in Christiania, I have this year seen a sponge, coming from the dark blue Silurian limestone of that region, which I, although it is only imperfectly preserved, ascribe to our species.

Siphonia excavata is synonymous with *Astylospongia præmorsa.* This species was created by Goldfuss from a single specimen from the Bonn Museum, which differs from the original specimen of the *Siphonia præmorsa* only by a deeper excavation of the crown, coming from disintegration. The peculiar, concentrically wrinkled coating of the under side (similar to the epitheca of some anthozoa, but occurring also in other fossil sponges), which the specimen exhibits, I have observed in another specimen of the *Siphonia præmorsa*, from the Island of Gothland. If, therefore, these two species are to be united into one, this latter must receive the name *Astylospongia præmorsa*, because this name was given to the species in the condition of perfect preservation, while the name *Siphonia excavata* was given to a disintegrated specimen. So, also, Hisinger's *Siphonia stipitata* is evidently, from the drawing and description, not a different species, but merely a specimen in which the concave crown is covered with an accidental, conically projecting appendage of silica. The statement of D'Orbigny (pro drome ii., page 286), who calls the species *Jerea excavata*, and says that it is found in the chalk of Maestricht, is just as erroneous as many other statements of that author in regard to the places where, outside of France, fossils are found.

Note.—The above description of the genus *Astylospongia*, and the species *A. præmorsa*, seems to be confined to siliceous sponges; but other naturalists are of the opinion that they may be calcareous—that the fossilization, whether siliceous or calcareous, depended upon whether the infiltrating water held silica or lime in solution, and not upon the constitution of the sponge while living. One thing is certain about it that may be readily demonstrated: the fossil sponge found in the Niagara Group, near Waldron, Indiana, is not siliceous, but is calcareous; moreover, it belongs, without much doubt, to the genus *Astylospongia*, though I have not seen one polished, to show the spicula, and bears the name among collectors of the *Astylospongia præmorsa*. While the *Astylospongia*, from the Niagara Group, in Tennessee, is siliceous, it is calcareous from the contemporaneous strata in Indiana. The philosophy of its fossilization is clearly shown in the article, in this journal, by Harvey B. Holl, of England, and the error of Dr. Roemer, in supposing them to have been siliceous while living, clearly pointed out. It was but natural for Dr. Roemer to have supposed them all to be siliceous, because he saw none others among his collection from various parts of the world. His mistake, however, illustrates the danger of generalization from a limited number of facts.

Indian Mounds and Skulls in Michigan. Result of Explorations of Mr. Henry Gillman. From the Sixth Annual Report of the Trustees of the Peabody Museum of American Archæology and Ethnology, Harvard College; Prof. Jeffries Wyman, Curator. [From Am. Jour. of Science and Arts, January, 1874.]

A collection made by Mr. Henry Gilman, from a mound on the Detroit river, Michigan, explored by him for the Museum, consists of human remains and various objects buried with the dead. The latter are of the common kinds, such as stone chisels, one of much beauty, made of dorite, and highly polished, a spear point, arrow points, stone pendants, a stone boring tool, beads and ornaments made of shell and copper, an implement made of an antler, a miniature vase of the size of a common thimble, and two large and perfect vases of the oval pattern, and ornamented over the whole surface with cord marks.

One of the skulls, that of a fully adult person, is worthy of notice for its diminutive size, and for a remarkable extension of the lines for the attachment of the temporal muscle toward the top of the head. The average capacity of the Indian cranium, as given in the tables of Morton and Meigs, is eighty-four cubic inches, and the minimum observed by them sixty-nine cubic inches. That from the Detroit river mound measures only fifty-six cubic inches, or less than sixty-seven per cent. of that of the average Indian. In ordinary skulls the ridges of the temporal muscles on the two sides of the head are separated by a space of from three to four inches, seldom less than two, while in the Detroit mound skull this space measures only three quarters of an inch; and in this respect it presents about the same conditions as the skull of a chimpanzee. As the two other crania from the same mound offered no such peculiarities, the skull which has just been described must be considered simply as an extreme case of individual variation from the ordinary form. There are no signs of artificial deformity.

The single tibia accompanying this collection is somewhat flattened.

Mr. Gilman, under an appropriation made by the trustees, has explored a series of mounds at the head of St. Clair river, and the collections made by him have been received, and were accompanied with the following report:

The mounds situated at the head of the St. Clair river extend from south of Fort Gratiot for one and one half miles northward, along the west shore of the river and of Lake Huron. It is altogether probable that they reach much farther, both northward and southward; but I have traced, examined, and fully identified them for the distance mentioned. Similar works have been found on the opposite side of the river, in Canada. Isolated mounds in the interior also exist, an interesting example of which is seen on the west shore of the Black river (a tributary of the St. Clair), at a point about one and three quarter miles southwest of Gratiot; the mound referred to having been exposed, some years ago, by the grading of a road through it, resulted in the loss of a large amount of valuable relics.

With few exceptions, all these mounds have a general resemblance, and bear the appearance of terrace-like embankments, from ten to twenty and twenty-five feet in height; they are much longer than wide, and run nearly parallel to the general direction of the river and lake shore, which here does not vary much from north and south. They are mostly of the Drift formation, subsequently modified or added to by man for the various objects for which they were occupied, whether for the purposes of interment, habitation, or the manufacture of the rude implements connected with the daily life of that period; and, from the topographical features and the geographical position, they must have formed favorite places of retreat in war time.

Mound No. 1 is composed chiefly of sand and gravel, is about two hundred feet long by fifty feet wide, and is fifteen feet above the level of the river. It has rather abruptly curving sides, and is built on a slope of the ridge, of Drift formation, on which the village of Gratiot stands.

A large excavation, made about fifty feet from the south end of the mound, disclosed the remains of four human bodies, at a depth of four feet from the surface. In an area of about ten feet square the four crania, with a portion of the accompanying bones, were taken out, but were in so decayed and tender a condition that, with the exception of a skull and a few of the long bones and vertebræ, they mostly fell to pieces. The bodies evidently were buried in a sitting posture. This was very apparent in one case, where the femora were found bent upon and above the tibiæ, the vertebræ, etc., resting upon these, while the skull lay on top, face downward, as though it had leaned forward originally, and had finally fallen over into that position. This cranium is that marked skull No. 1, Mound No. 1; and the vertebræ and other bones thereto belonging may be found correspondingly marked. With these remains were associated fragments of pottery, the bones of fishes and birds, flint chips, and some stone implements of the rudest character. These last were mostly water-worn bowlders, apparently used as hammers, and almost invariably shattered; and net sinkers, flattish, irregularly elliptical stones, notched on the edges or partially grooved toward the center. It is interesting to notice that the tibiæ present the peculiar compression which I have found so marked a characteristic, and in such extreme degree in the tibiæ from the mounds on the Detroit river and the River Rouge, Michigan, establishing the fact that these, too, were platycnemic men.

After excavating to the depth of six feet, the coarse gravel of the Drift was encountered; but no further objects of interest being met with, the opening was extended in other directions to the westward, so as to open a lateral trench through the mound. This revealed several fireplaces, solid beds of black ashes, from one foot to eighteen inches thick, with fragments of pottery and bone, flint chips, sinkers and broken hammers interspersed. The fireplaces were invariably at or near the surface of the mound, showing it to have been occupied for habitation subsequently to being used for burial purposes. Openings made at two points, about fifty feet from the north end of the mound, and also at a third point, half-way between these and the first excavation, added no facts of special interest. Two excavations were then made at twenty-five feet from the south end of the mound, showing fireplaces with the beds of black ashes, two feet thick, and intermingled relics, similar to those of the fireplaces already mentioned. Some of the fragments of pottery taken out here were uncommonly thick and coarse. Beneath were small pieces of the bones of man, but nothing further worthy of mention. The encroachment of the town on this mound, and on those to the west of it, prevented a more satisfactory examination.

The oldest residents (some born and brought up here) knew nothing of the character of the mound, though they remember that many years ago it was covered with a large forest growth.

Mound No. 2, which lies two hundred feet northwest of Mound No. 1, is over five hundred feet in length by from one hundred to one hundred and fifty feet wide, and of the general height of twelve feet above the level of the St. Clair river. It is bounded on the north by a small stream, known as McNeil's creek, which also runs southwardly all along its eastern slope, as well as a part of the south end of the mound. The ordinary observer will scarcely fail to notice that this mound is something more than the work of nature. Its sides have a graceful, gradual slope, with the exception of the side fronting the river, which is abrupt and terrace-like, even where not washed by the creek. Between the creek and the River St. Clair is some low lands with ponds, where are a few outlying mounds, small and of slight elevation. About two hundred feet of the south end of Mound No. 2 is a clear of trees, except on the sides, and is covered with a smooth, green turf. Excavations were made in a number of places, showing that this entire end of the mound was covered with a solid crust of black ashes, from eighteen inches to two feet thick. So hard and solid was this crust, that layers of it, in large pieces, several inches square and thick, were taken up unbroken. Fragments of pottery, showing a great variety of patterns, bones of animals, birds and fishes (some of the larger bones evidently smashed), flint flakes and chips, with stone implements, consisting principally of arrowheads, hammers and sinkers, were found intermixed with the ashes. The abundance of the sinkers, and particularly of the broken hammers, is a remarkable feature. Though such rude utensils, a selection from them is preserved, so as to give an idea of their character. I have not found elsewhere a similar condition of things, and believe that this end of the mound furnishes a nearer approach to the "refuse heaps" of the Atlantic coast than anything I have seen elsewhere on the shores of the Great Lakes. The absence of the shell deposit, however, makes a marked difference. I can not find that those ancient inhabitants of this region had much recourse to shell-fish as an article of diet. The great abundence of fishes, and the ease with which they were captured, together with the multitude of land game, left them under no necessity to use the inferior fresh-water mussels for food.

From the large quantity of pottery fragments and broken hammers, together with the thick bed of ashes covering so wide an area of this mound, I incline to think that this must have been a point where the manufacture of their pottery was carried on to an unusual extent. The broken hammers may be accounted for by their having been fractured in pounding the grains used as food, and in cracking the bones of animals for the extraction of the marrow, indications of which are not wanting. The pottery found in both these mounds exhibits an unusual variety of patterns; though not a single utensil was taken out entire.

For want of time the investigation of the northern part of the mound, which is elevated at its center from two to three feet above the portion covered with the ash-bed, was confined to three points. No additional information was obtained, however, further than establishing for it a like origin with the other mounds.

All the northern portion of the mound, and also the sides of the southern portion are covered with a large second growth of trees. These consist chiefly of White Pine (*Pinus strobus* L.), Scarlet Oak (*Quercus coccinea* Wang.), White Oak (*Q. alba* L.), and Basswood (*Tilia Americana* L.). The trunks of some of these trees have a diameter of from eighteen inches to two and one half feet. A few decayed stumps of the original forest still remain; these average four feet in diameter.

Mound No. 3.—After the exploration of four other mounds, three lying northward, the fourth northwestward of Mound No. 2, which contributed no additional facts of particular value, other than their identity of origin with the rest of the group, attention was next directed to Mound No. 3, which proved to be the most interesting of the entire series. This mound is situated three quarters of a mile northeastward of Mound No. 1. It is about five hundred feet in length, and in breadth varies from seventy to ninety feet; while its height above the surface of Lake Huron is twelve feet, or not more than five feet above the general level of the surrounding land. In general direction it corresponds to the other mounds, and there is little in its appearance to suggest its character or call the attention of any other than a practiced eye.

A large excavation was made at its widest part, and about its center. Within two feet of the surface the bones belonging to a single body were unearthed, but in so tender a condition, from age, that they mostly crumbled to pieces. A few bones of birds and fishes were found with them. Some of the decayed roots of an oak tree stump, ten feet to the westward (and which will be further alluded to), had grown over and around these bones. The excavation was deepened, widened, and carried farther to the eastward, opening a trench to the depth of six feet, but only small fragments of human bones resulted. The trench was then opened to the westward, toward the stump of the oak. When at the depth of five feet we came to a skull (No. 1, Mound 3). Some of the bones first taken out overlay this, and decayed roots of the oak, as thick as a man's arm, stretched above it. The other bones belonging to the body appear dwarfish. It was buried with the head to the east, and the legs seem to have been drawn up, and not stretched out at full length. On removing these remains, we found, immediately underneath, a third body, placed so closely that the skull of the upper rested on that of the lower. At the head was a large quantity of the bones of birds and fishes, in a compact mass, as though once held in some wrapping or vessel which had decayed. These were pressed against the skulls, so that in some cases they adhered to them, and are, no doubt, the remains of the food placed with the dead. Such of the bones as could be removed are preserved, but a great portion crumbled to pieces. This body was buried with the head to the eastward. The roots of the oak tree had penetrated the bones in many cases, the long roots presenting some interesting examples of this, as the roots in their natural growth had first filled, then burst, the bones, so that in several instances the parts of the bone surrounded the now decayed root imbedded in it. Such pieces as held together are forwarded. This tree, which evidently belonged to the second growth of timber, was, I think, a scarlet oak (*Quercus coccinea* Wang.), as the majority of the wood covering the southern half of the mound, is of this species, together with white pine. The decayed stump was two feet in diameter at the base, and at one foot above the ground divided into three trunks or main branches, each nine inches in diameter. These had been cut down, apparently, many years ago; and as between the first and two subsequent burials must have occurred, in all probability, some lapse of time, and the oak must have sprung up, reached its growth, been cut down, and its stump finally have decayed long afterward, some slight idea may be had as to the age of the first burial.

The trench was now opened to the oak stump, when, from directly beneath it, skull No. 3 was taken out with the accompanying bones. Upon this skull lay a plate of mica, five by four inches, of a quadrilateral shape, the corners worn off. A pebble of water-worn coral rested upon the mica, as if to keep it in place. About the neck of the deceased a necklace of remarkable construction had apparently been hung. This uncommon ornament was composed of the teeth of the moose, finely perforated at the roots, alternating with wrought beads of copper of different lengths, and the perforated bones of birds, stained a fine green color, the stain, in a few pieces preserved, being wonderfully fresh. Small portions of the cord to which they had been attached are still partially preserved and remain in the apertures of the copper beads. I suppose that the teeth alternated with the copper beads and the stained bones. One copper bead, which adheres by its oxidation to the perforated part of a tooth, sustains this conclusion. A rude stone axe, partially polished, lay beside these remains. All indicated that the dead had been peculiarly honored in his burial, and that he had been, perhaps, a noted personage.

Immediately to the northward of this body another was taken out, skull No. 4, with the remaining bones. These were under the edge of the oak stump, and, as well as the remains of No. 3, were surrounded with masses of roots. Both bodies lay nearly side by side, and at the same vertical plane, five feet below the surface. As in the other cases, the bones of birds and fishes were found with the remains, but in small quantity.

The excavation was next carried southward, through the center of the mound, for a short distance; but no relics being met with other than a few fragments of broken hammers and flint chips, it was next opened in the opposite direction, northward, thus giving it the form of an irregular Latin cross. When a few feet to the northward of the remains last taken out (No. 4), we came upon skull No. 5, and following up the indications, recovered such of the remaining bones as could be preserved. With this body a flint arrowhead and some other rude stone implements were found; also a number of small shells, the species of which I have not determined, but which appear to have been used for some special purpose, perhaps as ornaments, as they were ground smooth at the base. About twelve of these were recovered, but there must have been many more originally, as a large number of them crumbled to dust, and also some of them might easily have been overlooked. A short distance westward of the last relics skull No. 6 was taken out. The accompanying bones, as in the cases of the others, were very tender, and it was with extreme difficulty that any of them were recovered. Tibiæ exhibited the compression previously referred to in a marked degree. A large mass of fish bones lay in front of this body, which, like the previous remains (skull No. 5, etc.), was buried placed on its right side, with the head toward the east and the limbs drawn up closely to the chest. It is possible that they may have been buried in a sitting or crouched position, and have afterward fallen over; but I think they were buried as first mentioned. The absence of pottery with the interments in this mound is worthy of note, only two fragments being found in any part of the mound, and these apparently accidentally dropped.

Isolated excavations in different places throughout the extent of Mound No. 3, as also in a mound sixty feet to the west of it, contributed nothing specially entitled to record.

Mounds Nos. 4, 5, etc.—Mound No. 4 is eight hundred feet north-east of Mound No. 3. It is three hundred feet long by from thirty to fifty feet wide, and is a low, sandy ridge, with a series of nine conical elevations running along its length, and rising two or three feet above its general level, they having a diameter of from twenty-five to thirty feet.

Mound No. 5 is fifty feet to the westward of Mound No. 4, and is of a conical shape, forty feet in diameter, and nearly twelve feet above the level of Lake Huron, being between three and four feet higher than No. 4. Two other mounds of a smaller size but similiar shape lie to the north of it.

From Nos. 4 and 5 were obtained a few stone implements, fragments of bones and pottery, with flint chips and the usual bowlder-hammers, mostly fractured. Our limited time prevented as thorough an investigation of these mounds as their appearance certainly warrants. I believe the removal of those conical elevations in Mound No. 4 would be rewarded with interesting discoveries.

Other mounds to the northward and westward, belonging to the series, were also examined to the extent of confirming their claims to a like origin with those more thoroughly explored. A mound south of Mound No. 1 (the first investigated) contributed a few stone implements, which are forwarded. The large implement appears to me to resemble a spade, but may have been designed for some other use than that apparently indicated.

In conclusion, I would say that the facts observed fully prove this extensive group of mounds a rich field for more exhaustive research. And here I repeat the interesting fact, that all the tibiæ unearthed invariably exhibited the compression or flattening characterizing platycnemic men. Unfortunately the bones generally crumbling to pieces prevented satisfactory measurements. But sufficient evidence was obtained (in connection with my discoveries in other parts of Michigan) to establish the point, that this race, from the Detroit river to the St. Clair and Lake Huron, was marked with platycnemism to an extreme hitherto unobserved in any other part of this country, or perhaps any other country in the world. I can not but believe, from what I have seen, that future investigation will extend the area in which this type of bone is predominant to the entire region of the Great Lakes, if not of the Great West; or, in other words, that at least our northern "mound-builders" will be found to have possessed this trait in the degree and to the extent denoted. I am unable to say whether this peculiarity prevails in our modern Indian or not.

With the exception of the rude stone hammers, and the sinkers, the number of perfect stone implements seems to me unusually small throughout this entire series of mounds. The question arises: Had this people the habit of sometimes breaking the stone implements cast into the burial mounds? Or, were broken ones selected for this purpose, as being of little other use?

On Remains of Land Plants in the Lower Silurian; by LEO. LESQUEREUX. From the Amer. Jour. of Science and Arts, January, 1874.

[The gist of the following remarkable statement, from the pen of a distinguished naturalist, may be taken with a grain of skepticism. It will require further proof before the discovery of land vegetation in the Cincinnati Group becomes an admitted scientific fact.]

From a recent discovery it now seems that traces of land vegetation exist in the Lower Silurian strata of this country. A few months ago I received from Rev. H. Hertzer two specimens, representing branches or small stems, of a species, referable to *Sigillaria*, and reported to have been found by Dr. S. S. Scoville on Longstreet creek, near Lebanon, Ohio, in clay beds positively referable to the Cincinnati Group of the Lower Silurian. The discovery of the remains of land plants in this formation is too remarkable a fact to be accepted without positive evidence. Being at that time about to take the field for geological explorations, I merely took a sketch of the specimens, and returned them to the owner, purposing to examine more closely into the matter at a future time, either by going to Lebanon, or by corresponding with Dr. Scoville. On my return, as Rev. Mr. Hertzer had parted with the specimens, I sent to Dr. Scoville a sketch of the fossil under consideration, in order that he might recognize it, if it had been in his hands, and with the request to positively state whether he himself found the specimens, and when, and whether he had any more of the same kind. In his answer, he writes: "I can say now most emphatically, that I found on Longstreet creek, about six miles east of Lebanon, a fossil which resembles the sketch accompanying your letter in all the essential features. The specimen was, I think, in two pieces, or perhaps Mr. Hertzer took only one piece. I know within a rod or two where it was found. Its position or horizon, in the Lebanon beds, was about the middle. Should any one question the accuracy of my statement in regard to the discovery of a specimen of this character, in the locality designated, I would refer them to Mr. S. R. O'Neall of this place, who has paid much attentian to geology, and who will support my assertion, so far, at least, as to say: that I have described to him several times, and even but a few days since, the specimens under consideration." In a postscript to this letter, Mr. O'Neall confirms the statement in regard to the specimens in question.

There can be, therefore, no doubt as to the locality where these vegetable remains have been found, or the geological age of the strata. The clays of the Lebanon beds are full of Trilobites, of the same species that abound in the clay beds at the base of the Cincinnati Group—*Calymene senaria.* The only question to be settled is the true character of the plant which the specimens represent.

As I have said above, there were two fragments of small stems or branches, referable to the same kind of vegetable; one, more complete, about two inches thick, cylindrical, the whole substance transformed into soft, gray clay, the bark, or the outer surface only, distinctly moulded into clay, as is generally the case in specimens of this kind, and marked by rhomboidal, continuous, enlarged bolsters, surrounding the stem in a spiral, bearing at the middle a small oval or rhomboidal scar, less distinct, however, though well recognizable, and presenting the characters of stems of *Sigillaria Serlii* Brgt. or *S. Menardi* Brgt. The study of the specimens, as far as I was able to do it, left me undecided only in regard to their positive reference to the one or the other of these two species, on account of the somewhat obscure form of the internal scars. Though the Cincinnati Group has remains of Fucoids of large size, none has as yet been found there, to my knowledge, as large as these stems. And the peculiar form of the bolsters, placed in spiral around the stem, similar in form, equal in size, regularly convex, preclude the supposition that the remains represent some new kind of marine plants, or are attributable to a concretionary structure. We have, therefore, to admit them as representative of land plants, and thus to recognize the existence of traces of land vegetation in the Lower Silurian, the lower part of the Cincinnati Group being the equivalent of the Trenton Group of New York.

[The occurrence of vegetable remains in clay beds abounding in remains of Trilobites is not subject to objection. The Coal-measures of the West have strata of shale, clay, limestone, even sandstone, where animal and vegetable remains are found together in abundance. I have found Trilobites in the shale overlaying coal beds at Summit Portage, Pennsylvania, with *Sigillaria, Stigmaria,* etc., and species of the same kind of animals, with plants too, in sandy clay beds of the upper Coal-measures of Indiana.]

This discovery is the more remarkable, since we have, as yet, no records of vegetable remains from the Silurian of North America, except fragments of stems and rhizomes of *Psilophyton,* observed by Dawson in the Gaspé Group of Canada. On these Dr. Dawson remarks:

"Accordingly, it is in Gaspé that, as yet, we have the only link of connection of the Erian (Devonian) flora with that of the Silurian period. In the marine limestone of Cape Gaspé, holding shells and corals of Lower Helderberg age, along with some indeterminable plants, probably Fucoids, we have, as already stated, fragmental stems and distinct rhizomes of *Psilophyton*, some of them showing the scalariform axis well preserved. These fragments must have been drifted from the land; and, as in the immediately succeeding Lower Devonian beds, *Psilophyton* is associated with *Prototaxites*, *Arthrostigma* and *Calamites*, but is the most abundant of the whole, it is not unlikely that in the Upper Silurian land it was associated with plants of these genera." In Europe, too, the first remains of land plants have been found in the Lower Devonian, and, as yet, only a single specimen of a *Sigillaria*, described by Göppert as *S. Hausmannana*. It was found as early as 1806, by Hausmann, during his geological exploration of Scandinavia, in a red Devonian quartzite, just above strata of the Upper Silurian, where *Favosites polymorpha* was identified. Göppert, from whom these details are quoted, remarks that, on account of the presence of this species of *Favosites*, Murchison admitted these strata to be Lower Devonian.

With the exception of the Lebanon specimen, the geological formations of the United States have not afforded, as yet, any records of land plants earlier than those of the Lower Devonian. In Ohio and Kentucky vegetable remains of this kind have been found at different places, mostly in concretions, including trunks or fragments of wood representing species of Conifers of the section of the *Araucariæ*, together with Lycopodiaceous plants: *Stigmaria*, *Sigillaria*, and *Lepidodendron*. In Pennsylvania a *Lepidodendron*, *L. Primævum* Rogers, and a *Sigillaria* have been obtained from the same horizon. These fragments are as yet rare, and have not been satisfactorily determined, on account of the imperfect character of the specimens, mostly petrified pieces of wood, whose structure is studied with difficulty. It is certain, however, that in the Middle Devonian we have representatives of three distinct groups of vegetables: the Cellular Cryptogams, in a quantity of marine plants, the Vascular Cryptogams, in Lycopodiaceous plants; *Lepidodendron*, *Sigillaria*, etc., and the Phænogamous Gymnosperms, in the *Conifers*.

Strophomena alternata.—In the note referring to the locality and position of the *Strophomena alternata*, page 91 of the "Ohio Paleontology," there occurs the following mistake, to wit: "In Ohio, none of its varieties occur much below the tops of the hills at Cincinnati." The fact is that some of its varieties occur at all elevations above low water-mark.

A Succinct Review of Recent Attempts to Explain Several Remarkable Facts in the Physiology of Spiders and Insects. By JOHN BLACKWELL, F. L. S. [From Jour. of Pro. of Linnæan Society, vol. vii., p. 154.

My friend, Mr. Meade, in his valuable report "On some Points in the Anatomy of the *Araneidea*, or true Spiders, especially on the Internal Structure of their Spinning Organs," has been induced by his researches to adopt the opinion that these animals can propel from their spinners, to a considerable distance, fine lines, formed of the viscid fluid secreted by appropriate organs, situated in the interior of their abdomen. This hypothesis, based on zootomical considerations, being directly opposed to the conclusions arrived at by myself, from numerous carefully conducted experiments, merits an impartial examination.

After having briefly stated the general results obtained by his dissection of several species of spiders, and minutely described the organization of the internal vessels that elaborate the material which, on issuing from the papillæ connected with the spinners, forms filaments of extreme tenuity, Mr. Meade remarks, "I have now arrived at the most interesting, but most difficult part of my task, viz., the question whether there is anything in the structure of the silk-forming organs that will decide the question as to the power of spiders to eject their threads to a distance. Looking at the strong fibrous coat on the ducts of the membraneous sacs, and the fibrous tissue surrounding the glands themselves, I think that they must possess a powerful contractile power, which may also be increased by the muscular coat of the integument, enabling the spider to compress its abdomen. May not the striated bands of muscular fibers, which run in a parallel direction down the middle of the abdomen quite into the interior of the spinnerets, and surround the termination of the ducts, also assist in this object? They are not attached to the tegumentary coverings of the spinnerets like the other muscles, and can not, therefore, be for the purpose of moving these processes; their action must be to draw the spinnerets inward." Such is the evidence supplied by dissection in support of the opinion that spiders can forcibly eject their lines to a distance.

Now, it is manifest, from well known physiological facts, that the muscles distributed to the spinning organs perform various functions: the office of some being to give motion to those parts, of others, to close either the minute aperture in the dilated base of the tubular papillæ, or that of the fine ducts which terminate the vessels that secrete the fluid employed by spiders in the process of spinning, as its issue from the papillæ can be instantaneously prevented at the will of the animals; others, moreover, must possess a contractile force sufficient to propel the fluid to the open extremity of the delicate hair-like papillæ, exactly as the non-viscid fluid, propelled by the contraction of the muscles connected with the vessel that secretes it, passes out of, but is not ejected in a stream from, the minute orifice situated near the extremity of the fang that teimi nates the falces.

To this extent I am prepared to admit the influence of the muscles that contribute directly or indirectly to the action of the spinning apparatus; but that a remarkable viscid fluid, which immediately becomes concrete on exposure to the air when drawn out in a filament of such marvelous tenuity as the lines produced by spiders, can, notwithstanding its extreme levity and flexibility, and quite irrespective of the size of the animals producing it, be propelled by any physical power with which they are endowed in a straight line of many feet in length, through a resisting medium liable to rapid fluctuations like the atmosphere, does appear to be in the highest degree improbable, and is, as already asserted, directly at variance with the result of an extensive and elaborate experimental investigation of the subject, a brief abstract of which I proceed to give.

Spiders, if placed on wooden or metallic rods set upright in glass vessels with perpendicular sides, containing a sufficient quantity of clean water completely to immerse their bases, in vain attempt to effect an escape from them in a still atmosphere; all their efforts to accomplish their desired object, though perseveringly persisted in, proving quite unavailing when they are placed under a glass shade, or in any situation where the air is not liable to be disturbed. However, should individuals thus insulated be exposed to a current of air, either naturally or artificially produced, they instantly turn the abdomen in the direction of the breeze, and emit from the spinners a little of their viscid secretion, which, being carried out in a line by the current, becomes connected with some object in the vicinity, and affords them the means of regaining their liberty. This line uniformly moves in the direction and with the velocity of the stream of air; but if, while proceeding from the spinners, it be subjected to the action of a lateral or opposing current, it immediately becomes deflected from its course by the new impulse thus imparted to it.

I may here remark that numerous species belonging to various genera of spiders,—*Drassus ater*, *Ciniflo similis*, *Ergatis latens*, *Tegenaria civilis*, *Cœlotes saxatilis*, *Dysdera erythrina*, and *Oonops pulcher*, for example,—though provided with highly organized spinners, yet do not appear to be endowed with the instinct to avail themselves of a current of air for the purpose of transmitting their lines to a distance.

The manner in which the lines of spiders are drawn out from the spinners by a current of air admits of an easy explanation. As a preparatory measure the extremities of the spinners are brought into contact, and viscid matter is emitted from the papillæ; they are then separated by a lateral motion, which extends the viscid matter into filaments connecting the papillæ; on these filaments the current impinges, drawing them out to a length which is regulated by the will of the animal, and on the extremities of the spinners being again brought together, the filaments coalesce and form one compound line.

The only legitimate deduction from the foregoing experiments, which have been frequently repeated under every variety of circumstances likely to affect the result, appears to be that the lines produced by spiders are not propelled from the spinners by any physical power possessed by those animals, but that they are invariably drawn from them by the mechanical action of external forces.

Sec. 2. The importance of the greatly diversified form of the remarkable organs connected with the radial and digital joints of the palpi of male spiders, in affording valuable specific characters in numerous cases in which species so closely resemble each other in size, color and economy, as scarcely to be distinguished, except by minute differences in their external structure, is beginning to be duly appreciated by arachnologists, whose attention hitherto has been almost exclusively directed to investigations having for their object the discovery of the function performed by those organs—a highly interesting problem undoubtedly, the solution of which long continued to exercise the skill and ingenuity of zootomists and physiologists. Though the palpal appendages are now known to have a strictly sexual character, and have, in fact, been demonstrated by experiment to constitute a true intromittent organ, absolutely essential to fecundation, yet no direct communication has been ascertained to exist between them and certain vermicular vessels situated in the abdomen, and usually regarded as testes, whose ducts terminate in the space intermediate between the branchial stigmata. M. Dugés has attempted to obviate this difficulty by shrewdly suggesting that these parts may have been voluntarily brought together prior to the act of copulation, and then proceeds to ask, "le conjoncture" (palpal organ) "ferait-il alternativment l'office de siphon absorbant et d'organe éjaculateur?"—a question which he answers in the following terms: "cela se peut, mais je n'ai rien pu observer, qui justifiât directement cette conjecture."

In a concise notice of a work on the habits of the *Arachnida*, by A. Menge, given in the "Reports on Zoology," for 1843 and 1844, p. 195, published by the Ray Society, the following passage occurs: "Copulation. It was reserved for the author to solve the physiological enigma which this act had hitherto presented. The spoon-shaped palpi of the males are in fact the copulative organs, with which they take the semen from the appropriate openings of the seminal ducts on the base of the abdomen, and transfer it to the sexual opening of the female. The procedure is carefully described in various spiders." Not having had an opportunity of perusing the work of M. Menge, I am unable to state the particular observations which have led to a conclusion so precisely in accordance with the supposition previously entertained by M. Dugès.

This view of the subject I am incompetent either to confirm or refute, as in the course of extensive and minute investigations I have not succeeded in observing the act above described; and yet in numerous cases it ought to be very apparent, as the shortness of the palpi would render a strong inflection of the cephalothorax toward the inferior surface of the abdomen absolutely requisite, before they could be applied to the part indicated as the seat of the seminal ducts.

I shall conclude these remarks with the statement of a few facts bearing upon the question, which have come to my knowledge in pursuing researches relative to the generation of spiders.

In the act of copulation, the extremity of the organ of each palpus of the male, in a state of tumefaction, is usually introduced alternately into the vulva of the female, and that many times in succession, without being once brought into contact with any part of its own abdomen, though it is very frequently conveyed to the mouth; and I have observed a male *Lycosa lugubris* apply its right palpus eighty times, in the manner above described, to the vulva of a female (both of which had been placed in a clean glass phial), without the possibility of bringing it into contact with the inferior surface of its abdomen, except by a very conspicuous change of position; and as an equal number of similar acts were performed by the left palpus, we have the extraordinary fact of the palpal organs being employed 160 times during this greatly protracted process, unaccompanied by any contact whatever with the part where the seminal ducts are considered to terminate.

A male *Agelena labyrinthica*, confined in a phial, spun a small web, and among the lines of which it was composed I perceived that a drop of white, milk-like fluid was suspended; how it had been deposited there I can not explain, but I observed that the spider, by the alternate application of its palpal organs, speedily imbibed the whole of it. Perhaps the only safe conclusion to be drawn from this very remarkable circumstance, taken in connection with the previously well ascertained office of these parts, is, that it affords a complete answer in the affirmative to the question, asked by M. Dugès, namely, "le conjoncture ferait-il alternativement l'office de siphon absorbant et d'organe éjaculateur?"

SEC. 3. My explanation of the means whereby various animals are supported in their movements on the vertical surfaces of highly polished bodies having recently been called in question, I am induced to offer a few remarks in vindication of its accuracy.

Mr. Tuffen West, in treating "On certain Appendages to the Feet of Insects subservient to Holding or Climbing," advocates the hypothesis, that the papillæ distributed over the inferior surface of the pulvilli of flies and other species of the class *Insecta* act separately as independent suckers, adhesion being assisted by the emission from each of a small quantity of fluid. This view of the subject, being absolutely irreconcilable with the results of observations and experiments regarded as having established a wholly different conclusion, I am not prepared to adopt. That fluid is emitted from the papillæ connected with the pulvilli of the house-fly and flesh-fly when in motion is unquestionable, as finely pulverized nitrate of silver brought into contact with those parts is immediately acted upon by it; but that its agency is merely to effect a more complete vacuum between the climbing apparatus and the plane of position is evidently inadmissible. This fluid, which appears to possess a moderate degree of viscidity, assumes a gelatinous consistency when coagulated by exposure to the atmosphere, and by its adhesive property enables animals provided with the requisite organs to move with facility and security on the vertical surfaces of dry, highly polished bodies. In confirmation of the explanation of the phenomenon here insisted on, many facts might be advanced; but it will suffice, in the present instance, to direct attention to one, the decisive character of which can not be mistaken.

That flies are not supported on the vertical sides of highly polished bodies by the pressure of the atmosphere, experiments with the air-pump plainly demonstrate; for they can not only traverse the upright sides and the interior of the dome of an exhausted receiver, while their physical energy is unimpaired, but individuals occasionally remain fixed to the sides of the glass after they have entirely lost the power of locomotion—a circumstance which can only be explained by admitting the adhesive property of the fluid emitted from the extremity of the papillæ on the inferior surface of their pulvilli.

To the same cause must also be attributed the power of spiders that are provided with scopulæ or tarsal brushes, to run with celerity on the vertical surfaces of highly polished bodies, as those instruments consist of numerous appendages, slightly curved downward, and somewhat enlarged toward their extremity, which is densely covered on its inferior surface with minute, hair-like papillæ, for the emission of a viscid fluid, but which, from their organization, can not possibly contribute to the formation of a vacuum.

The foregoing solution of this interesting physiological problem I have reason to believe is applicable not to insects and spiders alone, but also to some species of reptiles.

Facts Relative to the Movements of Insects on Dry, Polished, Vertical Surfaces. By JOHN BLACKWALL, F.L.S. [From Journal of Linnaean Society, vol. viii., p. 136.]

As objections continue to be urged against the opinion that flies and other insects of various species are enabled to move on the vertical surfaces of highly polished bodies, by the emission of an adhesive fluid from the numerous, hair-like papillæ distributed over the inferior surface of their pulvilli, the statement of a few plain facts for the consideration of dissentients, and especially of those who still advocate the hypothesis, that flies, in such instances as those referred to above, are supported in their movements mainly by the pressure of the atmosphere, may, perhaps, be deemed deserving of attention.

Without the slightest intention to undervalue the importance of microscopic researches into the organization of the parts in question, I may be permitted to remark that the careful observation of phenomena and judiciously selected and skillfully conducted experiments afford equal if not superior advantages with regard to the determination of the function they perform; and that the two methods of investigation should be pursued contemporaneously, and, as far as opportunities will admit, in combination.

Having clearly ascertained, by repeated inspections of the pulvilli of flies under the microscope, both in a state of action and repose, that a vacuum can not possibly be formed between them and smooth surfaces to which they are applied, unless the papillæ with which they are provided separately contribute to produce such an effect, it was immediately perceived that a decisive test of the truth or fallacy of this conjecture might be obtained by means of the air-pump, and the result of its application was to demonstrate, not only that flies can traverse the upright sides and the interior surface of the dome of an exhausted receiver, while their physical energy is unimpaired, but also to establish the important fact that individuals occasionally remain fixed to the sides of the glass after they have entirely lost the power of locomotion, a circumstance which admits of only one explanation, namely, that an adhesive fluid is emitted from the extremity of their papillæ. The sole suggestion hitherto advanced, which has even the appearance of at all affecting the validity of the conclusion thus arrived at, is, that the specific gravity of flies is so low that a very slight degree of adhesive power is sufficient to sustain them in the position they occupy; but, low as it undoubtedly is, it greatly exceeds that of atmospheric air, and it is evident that the efficiency of the adhesive agency to support them on a polished, vertical surface *in vacuo*, thus conceded, must be ample to enable them to move on the glass of our windows in perfect security, under ordinary circumstances, without the adventitious aid of atmospheric pressure; the question of specific gravity, therefore, may be safely eliminated as being of no moment in any attempt to solve this interesting physiological problem.

The argument so much relied upon by opponents, is, that if flies retained their position on polished, vertical surfaces by means of an adhesive fluid emitted from the hair-like papillæ on the inferior surface of their pulvilli, they would, after remaining long in any situation, be unable to quit it by any muscular effort they could employ, without seriously injuring those delicate parts, in consequence of the tenacity that the fluid would acquire by dessication; whereas, it is well known that their movements are not in the least impeded by this circumstance. Plausible as this reasoning is, it appears to be based on the erroneous supposition that the properties of the fluid resemble those of animal glue, or vegetable gum, an assumption which is at variance with all the particulars that have been ascertained in connection with the phenomenon; in fact, the fluid merely assumes a gelatinous consistency on exposure to the atmosphere, and is readily removed from the pulvilli, when redundant, by the customary mode of cleansing those organs employed by insects, which it could not possibly be were it of the tenacity implied by the foregoing conjecture.

That flies are unable to walk on polished, vertical surfaces when breathed upon, till the aqueous vapor expelled from the lungs is copiously condensed thereon is an acknowledged fact; but it does not appear to be known that when thus treated they can not even retain the position they occupy, whether they make any visible effort to do so or not, a circumstance that seems to be quite inexplicable on the hypothesis that they are supported by the agency of atmospheric pressure, but which admits of a satisfactory explanation on the principle of a solvent fluid acting upon a gelatinous and moderately adhesive animal secretion; and these remarks apply to numerous species of insects, and also to spiders provided with scopulæ; but the latter, when they perceive their footing to be insecure, frequently attach themselves to the spot by emitting from their spinners a little of the viscid material of which their silken lines are formed, that possesses the property of being insoluble in water.

In spring, summer, and autumn, house flies may frequently be seen adhering so firmly to the upright surface of the glass of windows that they are incapable of extricating themselves, though they make every exertion to accomplish that object, yet, when breathed upon, till the aqueous vapor exhaled is condensed about them, they speedily fall from the spot to which they were previously attached so strongly. Now, that this remarkable affection of the house-fly can not be caused solely by a low state of atmospheric temperature, as it has been surmised, is evident from the circumstance that it often occurs in the hottest period of the year; in the months of July and August 1864, upward of twenty instances of this curious fact were noticed: it must be ascribed, therefore, either to feebleness, resulting from some other cause, or to an increase in the adhesiveness of the fluid emitted from the papillæ in the act of climbing. If it should still be insisted upon, that the phenomenon is the result of atmospheric pressure, it behooves the advocates of that hypothesis to explain in what manner a little condensed vapor causes the liberation of insects that are unable to accomplish the act by their own unaided efforts. That an organ deemed capable of so entirely expelling the air from the space between its extremity and smooth surfaces with which it is brought in contact, so as to produce a vacuum, should yet be incompetent to effect the exclusion of so dense a fluid as water, does certainly appear to be in the highest degree improbable.

[The adhesion of flies to the glass of windows and to other surfaces, toward the end of summer and in autumn, is usually caused by the growth from the interior of the body of a parasitic fungus (*Sporendonema muscæ*, Fries: *Empusa muscæ*, Cohn.)—G. B.]

The promptness and celerity of the movements of flies in an inverted position, or with their backs downward, on highly polished surfaces, and the certainty with which their hold is immediately secured when they alight upon them, would seem to preclude the possibility of the employment of muscular force on such occasions, adequate to the expulsion of the air between their delicate climbing apparatus, and the plain on which they move, to the extent required for the formation of an efficient vacuum; but every difficulty is at once obviated by admitting that a minute quantity of moderately adhesive fluid, which acquires a gelatinous consistency on exposure to the atmosphere, is emitted from the organs of sustentation. Unexceptionable evidence that such is the case has been obtained by observing that the extremity of each papilla becomes cauterized when subjected to the action of finely pulverized nitrate of silver; and that insects, when traversing a vertical surface of glass, leave upon it a visible and enduring trace of their path, for the better perception of which a lens, having a high degree of magnifying power, should be employed.

Though perfectly satisfied that the conclusion deduced by me from the experiment with the air-pump rests on too secure a basis to be subverted, yet a desire to remove all apparent difficulties which may be thought to militate against the view that I have promulgated of the means by which numerous species of insects and spiders, and even some reptiles, are enabled to move on dry, polished, vertical surfaces, must serve as my excuse for obtruding once more on the attention of naturalists a subject that has been the occasion of so much controversy.

On the Natural History and Hunting of the Beaver (*Castor canadensis*, Kuhl) *on the Pacific Slope of the Rocky Mountains*; by ASHDOWN H. GREEN, Esq. With Supplementary Notes by ROBERT BROWN, Esq., F.R.G.S. (Communicated by JAMES MURIE, M.D., F.L.S.) From Jour. of Proceedings of Linnæan Society, vol. x., p. 361.

I have been for three years almost constantly engaged in trapping beavers, so that what remarks I may have to make on their habits and history, though somewhat at variance with the stereotyped notions prevalent in compilations, are yet the result of my own independent observations.

About January their tracks may be seen in the snow near the outlet of the lakes where young fir trees grow. At this time they prefer young fir trees as food to any other kind of tree, the reason, doubtless, being that at this period the sap has not risen in the willow or alder (*Alnus oregana*). It is not often that females are caught in the spring; and the males seem to travel about, as the runs are not used so regularly as they are when the beavers are living near.

Some of the beavers become torpid during January, especially those living near lakes, swamps, or large sheets of water which are frozen. They do not lay in a store of sticks for winter use as stated by Captain Bonville (Washington Irving's "Adventures of Captain Bonville"), as one day's supply of sticks for a single beaver would fill a house—and if a stick were cut in the autumn, before the winter was over, it would have lost its sap, and would not be eaten by the beaver. A beaver never eats the bark of a tree that is dead, though he may gnaw a hard piece of wood to keep his teeth down. A little grass is generally found in the houses, but is used as a bed and not for food.

If February is an open month, the beavers begin to come out of their retreats, and frequent any running water near them; but it is generally March before the bulk of them come out of winter quarters. When they come out they are lean; but their furs are still good, and continue so till the middle of May—though if a trapper thought of revisiting the place, he would not trap after April, so as to allow them to breed quietly.

About the end of March the beaver begins to "call." Both males and females "call" and answer one another. Sometimes on one "calling," half a dozen will answer from different parts of the lake. I have known beavers to "call" as late as August. Males fight during the rutting-season most fiercely. Hardly a skin is without scars; and large pieces are often bitten out of their tails. The beaver holds like a bull dog, but does not snap. It shakes its head so as to tear. When trapped, it will face a man, dodge a stick, and then seize it, taking chips out of it at every bite. It seems to attack from behind.

The period of gestation is known with little certainty, as they are never trapped in summer. The female brings forth some time about the end of June; and it is a year before a beaver is full grown; and even then it has not the *embonpoint* of an elderly beaver.

I have read that the beaver breeds at any time during the year; but this can not be, or all the kittens that are trapped in the fall would not be of the same size. It produces from three to four at a birth. The teats are placed between the fore legs. The young (called kittens) whimper like young puppies when suckling, even when two months old. The females prefer deep, sedgy lakes to bring their young up in, and they feed on grass about that time of the year (July or August). They feed on willow about April, May, and June. I can not say whether they are born blind or not, but suspect so. They are very fond of water-lilies (*Nuphar advena*, Ait.) in the spring. It is with me a matter of uncertainty whether the female litters in a house, under the ground, or in the dry sedges; but I should think, under ground or in the houses. In the autumn more females are caught than males. Trapping commences in September, and continues to May; after that the trappers leave them alone, so that I do not know much about their doings in the summer.

They begin to build their dams about July or August, as soon as the summer floods begin to subside. For this purpose they generally choose a bend in the stream, with high and clayey banks, and commence by felling a large tree that will reach across the water; or they fell a tree on each side of the water, so as to meet in the center. They then float sticks from 6 to 4 feet long down to the dam, and lay them horizontally, filling in the spaces with roots, tufts of grass, leaves, and clay or mud. The branches of the first tree are the perpendicular supports, almost all the remaining sticks being placed horizontally and cross-wise. The last six or eight inches in height is very insecurely constructed, being nothing but mud and leaves.

The highest dam I ever saw was only about 4 feet 6 inches; but the generality of them are not above 2 or 3 feet. The action of the water, by bringing down mud, gravel, or fallen leaves, strengthens the dam, by making a sloping bank against it; and, the willow sticks of which it is composed sending forth their roots and shoots, the dam in course of time becomes a fixture, bound together as strongly as well could be. The winter floods almost invariably destroy the upper part of the dam, which is reconstructed afresh every year. The shape of the dam, is almost always semicircular, with the crown of the arch down stream, thus reversing the order of things; but I have no doubt this is in consequence of the heads of the first or principal trees being floated down stream when they are first thrown. The body of water raised by these dams varies, of course, according to the fall of the original stream, from a small hole of 20 feet diameter to a lake of miles in length. In the former case the beaver builds his house close to the dam, so as to get depth of water, and there saves himself from any hungry panther (*Felis concolor*, L.) or wolf, who might feel inclined to indulge in beaver meat. The beaver also burrows into the banks of streams, always taking care to have two entrances, one under (or close to) the water, and a smaller air-hole on land. With a good dog capital sport may be had on some of the smaller rivulets leading into or out of a lake. The houses are formed of water-logged sticks, placed horizontally in the water. They have always two or more entrances, and a small chamber with a little grass for the beaver to lie on. The top of the house is constructed very thick, to guard against attacks by animals. Mud and roots are used to make the house solid; but no mud is seen from the outside, as the top is covered with loose sticks left there by the beaver after taking the bark off. The houses are generally about 4 feet in height, and about 6 feet in diameter on the outside, and would hold about four beavers, though I have known small houses to hold two only.

The traps generally used in securing the beaver are large steel traps with a strong spring at each end, and fastened with a chain, from 4 to 6 feet in length, to a pole, which is stuck in the bottom of the water as far out as the chain will allow, so that the beaver, when he feels the trap, may run into deep water; and as he gets tired, the weight of trap taking him down, he drowns. A beaver, when trapped, never tries to get to land, but makes a dive for the deepest water; and should the water be shallower than four feet, he will, in a short time, amputate his foot so as to relieve himself. He always takes his foot off at a joint, and draws the sinews out of his shoulder instead of biting them through. The stump heals up; and I think the beaver is none the worse for it, though he gets shy, and, perhaps, tells the other beavers to beware of traps. A beaver is generally caught by his fore foot; and should the trap be set too deep below water, his toe-nail only gets caught. The trap is set in the beaver-run, or just where it springs into a hole in the bank. It must not be set in too shallow water, for then he amputates his foot, or in too deep, for in that case he does not get caught at all, but swims over the trap. The proper depth to set a trap is 5 inches. The beaver is then caught by his fore foot. Sometimes the teeth of a beaver are found to have grown beyond their proper length. I once saw one with the lower teeth 3½ inches beyond the gums. He was caught in a trap, and was miserably thin; but, singular enough, he had about the finest fur I ever saw. He was an aged animal. It is rare to see a beaver which has been trapped with its teeth whole, as they are often broken in trying to get out of the trap. A full-grown beaver weighs about 34 lbs. I am not an anatomist; but still I do not think there is anything very peculiar about its internal structure, except that the heart weighs a mere nothing—the cavities being so very large. An old beaver when shot sinks, a kitten floats. A good skin will weigh 2½ lbs.; but it is very rarely that one weighing that amount is caught in Vancouver Island. The Hudson's Bay Company give only from 75 to 85 cents per lb. at Victoria for peltries, so that a trapper now-a-days can not get very fat at the work. There are at present very few beavers on Vancouver Island or the main-land, compared with what there must have been some years ago; but they have been increasing for the last six years; and no doubt by the time beaver skins come into fashion again there will be a plentiful supply.

Supplementary Notes by Mr. Brown.

The following I add as an appendix to the foregoing observations of my friend, Mr. Green, whose opportunities for studying the animal were much superior to my own during my travels in Northwest America, and whose account is valuable as being the plain unvarnished notes of a hunter—a narration of facts very familiar to him, written with no reference to preconceived notions or received theories. First, therefore, regarding the range of the beaver. It is found all over British Columbia, Oregon, Washington Territory, and even south to California, and north to the limit of trees. It is not, however, found, as far as I can learn, in the Queen Charlotte Islands, but is abundant in Vancouver Island, though, curiously enough (in such a manner is history written), Colonel Colquhoun Grant, in his "Description of Vancouver Island" (Journal of the Royal Geographical Society, vol.

xxvii., p. 268), mentions that he has seen traces, and was not aware that the animal itself had been found. The fact of the matter is, he could have found abundance not far from his own door. Near Victoria, in Mr. Yales' Swamp, and in one near Dr. Tolmie's, are several beavers; and on the road to Cadborough Bay there are, in a small stream near where the road crosses, the remains of an old dam. In the interior they are almost everywhere abundant and on the increase. In a swampy lake near the mouth of the Cowichan Lake we found many; and an extensive swamp near the entrance of the Puntledge Lake was a great stronghold. On Young's Creek, flowing into the same lake, were many dams. In the spring of 1866, when crossing the island from Fort Rupert to the head of Quatseeno Sound with some Indians, a great portion of our route lay among these beaver ponds and dams. All through this district beavers swarm. The camps of the Indians were full of them; and the women laid before us the daintiest pieces of the meat, or exhibited to their white visitor all sorts of curiosities in the shape of fœtal beavers and beaver's teeth with which they were gambling, using marked ones in much the same manner as our dice. At the Hudson Bay Company's Fort we lived upon beaver during that spring—beaver roasted and beaver broiled; beaver tail and beaver joint; beaver morning, noon, and night! In regard to the beavers' houses, I am forced to come to the conclusion either that travelers who have written regarding the beaver in the country east of the Rocky Mountains have woefully taken advantage of a traveler's license, having listened to mere hearsay wonders without seeing for themselves, or that the habits of the beaver differ much in different parts of the country.

It is only after they have been pointed out to you that the "houses" can be recognized, as they seem like loose bundles of sticks lying on the water. In a recent account of the beaver in the British provinces in North America, by an anonymous writer, the houses are described as being exactly the same as I have seen them in the West, and not plastered domes. The vigilance of the little builders is so great, that it is rarely, unless closely watched for a long time, that they can be seen. A passing traveler rarely surprises them at their work.

My friend, John Tod, chief trader in the Hon. Hudson's Bay Company's service, during a long residence at Fort M'Leod (a post of that Fur Company, situated in the northern portion of British Columbia), has communicated to me his observations, which, differing in some respects, substantiate in the main those of Mr. Green. The beaver has from *four to ten young*—most often four, sometimes eight, rarely ten. It carries its young *six months*. It produces in *May*. When the female is going to have young the male takes the young of last year (for sometimes as many as three generations will remain around the paternal abode), and goes up a river several miles, remaining there until the female has produced.

The dams here, as everywhere else, are perfectly constructed, and with an opening in the middle for the current. The only approach to plastering their houses, which I have observed, is its giving a self-satisfied "clap" of the tail on laying down its load. The loads are carried between the top of the fore paws and the under surface of the head. The trailing of the tail along the ground gives the vicinity the appearance of being plastered. The house has two flats; the bottom one is on a level with the water; the top one is used to sleep in, and has communication with the water through the bottom. The top one has direct communication with the land. Sometimes they live in merely a tunnel or cave. In winter the Indians go along the edge of the ice, sounding with a stick; and wherever there is the opening of one of these tunnels, the sound being different, he watches and plugs up the opening. If these holes or tunnels are used as escapes from the houses, they break into the latter. If the beaver is not in, the Indian makes a hole in the ice. He then makes a great noise, and watches the rippling of the water to see if he is there, because his motion will have that effect. When alarmed he generally rushes for his hole; and finding it closed, he is often shot in his endeavor to escape. In *trapping*, some strong-smelling stuff (commonly castoreum in rum or cinnamon) is spread on the path. The trap is then set in the water, close to the bank, and covered with about four inches of water. The beaver, attracted by the strong-smelling substance, gives an approving slap of his tail, and starts off, if anywhere in the neighborhood, to investigate the booty; and as he is leaving the water, gives a "purchase," so as to spring up the bank on the very place where the trap is concealed. His food is principally willows. The bark is preferred, though the wood is eaten when nothing else can be got. It will gnaw through thick trees, apparently for the top foliage; for immediately the tree falls the beavers spring on the branches of it. A stump showing beaver-gnawing is not unlike Indian chopping (small irregular chops); and novices in the back woods often mistake them for Indian "sign." Large trees are universally felled so as to fall with the head to land, because, if required for floating down, the branches would impede it being floated off, while the difficulty of dragging it down is not so great, over and above the fact of the impeding branches being easily gnawed off. Much ingenuity is displayed to effect the fall of the tree in the proper position. I have often, in my walks and sails along the solitary rivers of the western wilds, seen three or four beavers piloting a large tree down stream, and noticed that when they were approaching its destination they shoved it into the eddies inshore. They always cut down the trees *above* their lodges, never on any occasion *below*. In winter *they have a store of food secured at some convenient distance from their abodes.* When they require any they start off to get it. They do not eat there, but bring it to their house, and there make their meal. Of the almost human intelligence of the "thinking beaver" the stories are innumerable; but many of them are much exaggerated, or even fabulous (such as Buffon's account). The following is tolerably well authenticated, my informants vouching for the accuracy of it: In a creek about four miles above the mouth of Quesnelle river, in British Columbia, some miners broke down a dam, in the course of the operation for making a ditch, at the same time erecting a wheel to force up the water. Beavers abounded on this stream, and found themselves much inconvenienced by these proceedings. Accordingly, it is said that, in order to stop the wheel, the beavers placed a stick between the flappers, in such a way as to stop the revolutions of the wheel. This was so continually repeated night after night, and was so artfully performed, as to preclude the possibility of its being accidental.

In "Notes on the Habits of the Beaver," presented to the Royal Physical Society by Mr. James M'Kenzie, of the Hudson Bay Company's service, and to all appearance most careful and trustworthy details are given, differing somewhat from those related by Messrs. Green (in the foregoing paper) and Tod.

When I lived among the Opicheshaht Indians, at the head of the Alberni Canal, V. I., I heard much about *Attoh*, the beaver, but remarkably little to the credit of its sagacity. They look upon it as a common-place animal, requiring no particular skill to trap. They used to tell us all sorts of stories about it; but I think they all contain a vein of fiction. Mr. G. M. Sproat has gathered some of this information into his excellent "Scenes and Studies of Savage Life," to which I refer. The beavers lie in these houses, as the Indian expresses it, "like boys;" but when the female has young ones, she goes into a separate bed or chamber, I could not ascertain which. There is no story in a beaver-house for convenience of change in case of floods; the waste-way is generally sufficient to carry off any extraordinary quantity of water. In the Alberni country, at least, the houses on the banks of lakes are abandoned when the water is very high; and the beavers go to small streams, which they form into a succession of diminutive lakes; in these they breed. He sleeps during the day, and comes out at night to feed. He can not see far, but he is keen of scent. The Opicheshaht approach to leeward at night, and spear the beaver, from a canoe, as he floats, eating a branch taken from the shore; or they shoot him when he is in shallow water, but not in deep water, as he sinks on receiving the shot. They also block up the opening into his house, break through the wall, and shoot or spear him.

The flesh of the beaver, especially when first smoked and then roasted, is not at all unwelcome as an article of food. The tail, when boiled, is a noted article of trappers' luxury, though, forsooth, if the truth must be told, rather gristly and fat, and rather too much for the stomach of any one but a northwestern hunter or explorer. "*He is a devil of a fellow*," they say, on the Rocky Mountain slopes; *he can eat two beavers' tails!*" The scrapings of a beaver's skin form one of the strongest descriptions of glue. The Indians at Fort M'Leod's Lake use it to paint their paddles; and the water does not seem to affect it.

When beaver was 30*s*. per lb., Rocky-Mountain beavers were piled up on each side of a trade gun until they were on a level with the muzzle, and this was the price! The muskets cost in England some 15*s*. These were the days of the "free trapper"—joyous, brave, generous, and reckless—the hero of romance, round whom many a tale of daring circles, the love of the Indian damsel, the beau ideal of a man, in the eyes of the half-breed, whose ambition never rose higher than a *coureur de bois*—a class of men who, with all their failings, we can not but be sorry to see disappearing from the fur countries. The fall of beavers' peltry rang their death-knell; and, as a separate profession, trapping is almost extinct, being nearly altogether followed, at uncertain spells, by the Indians and lower class of half-breeds. The world is fast filling in; the emigrant, with his bullock-team and his plough, is fast destroying all the romance of the far West—fast filling up with the stern prose of the plow and the reaping-machine and the whistle of steam what was once only claimed by the pleasant poetry of the songs of the *voyageur*, the *coureur de bois*—the hunters and trappers of the great fur companies! But perhaps it is better after all!

The beaver is easily domesticated, and learns to eat any vegetable matter, but requires water occasionally. One kept at Fort M'Leod got blind: but if it got access to water, it laved some on its eyes, and generally in an hour quite recovered its sight. It used to gather carpenter's shavings together, and carry them to the door; if the door was shut, it forced them up against it, finishing with a slap of its tail, as if it were building a dam. It had a great antipathy to the Indians. It would come into the Indian Hall, where the natives were seated, as is their wont, back to the wall. It would first take their fire-bag, then their axe, and so on until it had carried everything to the door, greatly to the amusement of the Indians. It would then attempt vigorously to eject the owner of the articles. Its "weakness" for gnawing exhibited itself in a very unpleasant manner; for occasionally, in the morning, the whole of the furniture was prostrate, the beaver having gnawed through the legs of the tables and chairs!

This leads me to remark that the beaver might be easily naturalized again in Britain; and though I can not recommend them in the light of a drawing-room pet, yet I can conceive no more pleasant inhabitant of our lakes and rivers. We must remember that at one time the beaver was an inhabitant of these islands, but became nearly extinct. This was, of course, not the *Castor Canadensis*, but the *C. fiber*, Linn.; for the remains found in Britain have now been decided to belong to the latter species, which is, I believe, not yet altogether extinct in Scandinavia. We have, however, historical accounts of its former abundance in this country; and I can not better conclude these desultory notices than by recapitulating the information we possess regarding it as a former inhabitant of the British Isles, referring for a more particular account of it as a Scottish animal, extinct within historic periods, to Dr. Charles Wilson's "Researches on Castoreum and the Beaver in Scotland." The earliest notice of it we know is in the ninth century, viz., in the Welsh Laws of Hywel Dha, where we read of it even then as a rare or valued animal of the chase; for while the marten's skin is valued at twenty-four pence, the otter's at only twelve pence, that of the Llosdlydan, or beaver, is valued at the great sum of one hundred and twenty pence, or at five times the price of the marten's, or ten times the price of the Otter's. It thus seems, even in the times of the heptarchy, to have been on the decrease; its sun had early begun to set. In the year 1158, Giraldus de Barri (or, as he is variously called, Sylvester Giraldus, or Giraldus Cambriensis), in his droll account of the itineration he made through Wales, in company with Baldwin, Archbishop of Canterbury (who journeyed thither in order to stir up the Welsh to join in the Crusades, and who afterward followed the train of Richard Cœur de Leon, and fell before Acre), tells us that in his day it was only found on the river Teivi, in Cardiganshire, and gives a curious account of its habits, derived in part from his own observations. In John Ray's time many of the places in the neighborhood of the river bore the name of *Llynyrafrange*, or the Beaver Lake, and for all we know to the contrary, may to this day. About the same time it was probably known in Scotland, but only as a rare animal. Hector Boece (or Boethius, as his name has been Latinized), that shrewd old father of Scottish historians, enumerates the *fibri*, or beavers, with perfect confidence, as among the inhabitants of Loch Ness, whose fur was in request for exportation toward the close of the fifteenth century; and he even goes further, and talks of an "incomparable number," though perhaps he may be only availing himself of a privilege which moderns have taken the liberty of granting to mediæval authors when dealing with curious facts. Bellenden, in a translation of Boethius' "Croniklis of Scotland," which he undertook at the request of James VI., about the middle of the sixteenth century, while omitting stags, roedeer, and even otters, in his anxiety for accuracy, mentions "bevers," without the slightest hesitation— "*Mony wyld hors and amang yame are mony matrikis* (pine martens), *bevers, quhitredis* (weasels) *and toddis* (foxes) *the furrings and skynnis of thame are coft* (bought) *with gret price amang uncouth* (foreign) *merchandis.*" It is, however, more than probable that the worthy historians were influenced by a little national pride when they recorded the beaver as an inhabitant of Loch Ness in the fifteenth century, as no mention is made of it in an act dated June, 1424, though *martricks*, *furmartes* (polecats), *otters* and *toddis* are specified. They were, perhaps, so strongly impressed by the wide-spread tradition of its existence in former days, as to be led to enumerate it among the animals of Scotland in those times; and it may be mentioned in passing that both worthies boast immoderately of the productions of their country. At the beginning of this century (at least) the Highlanders of Scotland had a peculiar name for the animal—Losleathan or Dobhran losleathan, "the broad-tailed otter." According to Dr. Stuart, of Luss, in a letter to the late Dr. Neill, quoted by Prof. Fleming, a tradition used to exist that the beaver or "broad-tailed otter" once abounded in Lochaber. That may be so or not; but at all events it does not now exist anywhere within the bounds of the British islands; and a considerable doubt might be still thrown on the accounts of the old writers, were not remains continually dug up in all parts of the country. I would fain hope that in a few years it may agnin be an inhabitant of our lakes and rivers.

The Cincinnati Group.

The Cincinnati Group is now an established technical term to designate that part of the Lower Silurian formation exposed in the Western States that was formerly called either the Trenton limestone, or the Hudson River Group. It is the equivalent of the Hudson River Group, and probably part or all of the Trenton Group. The black slate or Utica shale found in New York and in Canada, between the Trenton and Hudson River Groups, is wanting in the Western States, and it is therefore impracticable to have the same classification, as many fossils are common to both groups.

The exposure at Cincinnati was known for many years as the Trenton Group, both at home and abroad. Prof. Hall, of New York, and Sir Charles Lyell, both considered it as the equivalent of the Trenton. Later, however, Prof. Hall and others regarded it as the equivalent of the Hudson River Group; and, finally, during the progress of the Geological survey of Illinois, Meek and Worthen proposed to designate it as the Cincinnati Group. The reasons urged by them seemed to be satisfactory to all naturalists and geologists of the country, and the name was quickly adopted by the Indiana and Ohio geologists. It is now as firmly established as the name of any group belonging to any formation, and its signification as fully comprehended.

The only subdivision of the Cincinnati Group, founded either upon the stratigraphical appearance or fossil contents of the rocks that has yet been ascertained, is marked by the wave-like rocks at an elevation of about two hundred feet above low water-mark at Cincinnati, and even such a subdivision would be, to say the least, of very doubtful utility. These wave-like rocks are composed in a very large part of fragments of *crinoids*, principally of the *Heterocrinous simplex*, and appear to have been formed by the action of the waves in first breaking to pieces the animal skeletons, and then leaving them in ridges, as if to mark for all future time the course of the waves. These rocks are found in all the hills about Cincinnati, and as far east as Plainville. They have not yet been examined with that care necessary to determine whether they all mark the same course, or substantially the same course, of the waves, but many of them have a north and south direction, thus indicating an east and west wave, if it be true that they are the result of the action of waves.

A number of fossils are found below these rocks that have thus far not been found above them, and, on the other hand, many have been found above that have not been found below. Among those found below, and not known above, are *Triarthrus Beckii, Leptobolus lepis, Modiolopsis anodontoides, Ambonychia bellistriata, Orthis emacerata*, and the undescribed crinoid with the unusually smooth column. The fossils found above that are not found below are too numerous to mention. The fossils which are common to both elevations comprise more than half of all those found below these rocks. And yet on further examination it may appear that the causes which led to the formation of these waves on the rocks also caused a considerable change in the animals that inhabited the ocean at this place. At present, however, there is too little known on which to base definite conclusions, or to found a subdivision that would be of any advantage to the collector, or to science.

On Fossil Sponges.—[From the London Geological Magazine, vol. ix., pp. 309–343, July and August, 1872. By Harvey B. Holl, M.D., F.G.S.]

I. Introduction.—It has been said, with some degree of truth, that our knowledge of the lower forms of life has advanced *pari passu* with the improvements in the construction of microscopes; and, no doubt, very considerable progress has been made in some departments of investigation within the last few years. In the vegetable kingdom more especially has this been the case; and with respect to animals, the structure of the *Protozoa* has been especially elucidated by able observers, the Spongiadæ chiefly by the labors of Dr. Bowerbank.

Among the lower forms of extinct life progress has necessarily been slower, especially as regards the sponges; for although new forms have been described from time to time, the group collectively has never received that strict treatment of which it seems capable. Much has yet to be done toward the attainment of a better knowledge of their structure, mode of growth, and variation in form within the limits of the species, and not until this has been accomplished can a right understanding of the true affinities of the several members of the group be arrived at, or any successful attempt made at arrangement of the species and genera.

The little interest which appears to attach to the study of fossil sponges may possibly be due, in great measure, to the difficulties which lie in the way of a rigid determination of the species. This is owing to the inconstancy of the characters on which specific distinctions have been based; and consequently an enormous number of species have been created, the described characters of which are in many cases equally applicable to other forms, which are, nevertheless, totally distinct. Hence the subject is involved in a confusion which is rendered still more perplexing by the circumstance, that many of the original types on which the descriptions were based can no longer be traced. The means, therefore, of identifying the species is by no means easy, and in some cases it is impossible to identify them. As an example, we may mention the *Spongites clavellatus*, Mantell, from the chalk, of which there are two distinct forms, the one composed of a network of inosculating fibers, the other constituted entirely of branched and tuberculated spiculæ. The same may be said of the sponges included in the genera *Chenendopora*, D'Orb., *Cupulospongia*, D'Orb., etc., some of which are spicular, and others fibrous, and yet are precisely similar in their general appearance. In all these cases there are no means of clearing up the doubt, except by reference to the original type.

Like their living analogues, the fossil sponges are liable to great variation in form, and other external and obvious characters; and the remarks of Dr. Bowerbank on this subject are equally applicable to the extinct as to the living species: [" There is no class of animals in which the form varies to so great an extent (as the living sponges) according to difference of locality or other circumstances; and even where there is a striking normal form, it is rarely thoroughly developed until the animal has reached its full maturity." *Spongidæ* (Ray Soc.) vol. 1, p. 3. "As a generic character, form is inadmissible, inasmuch as each variety of it is found to prevail indiscriminately in genera differing structurally to the greatest possible extent.' [Ibid, p. 156.] Yet, on external characters alone nearly all the generic and specific distinctions of the fossil sponges have been framed, and very slight variation in external configuration, in the disposition of the oscules, or even in the geological position, has been thought sufficient for the creation of distinct species. Nevertheless, if we except the Foraminifera, there is no class of animals in which the outward characters are less stable, and like these, in conformity with the same low state of organization, there are none that have enjoyed longer range in geological time.

The insufficiency of mere external character for the purpose of differentiating the sponges, and the consequent difficulty experienced in framing specific descriptions precise enough for their identification has been long felt. This renders it desirable to discover, in the minuter structure, characters of a more permanent nature. With respect to the living sponges, this has indeed been done, more or less successfully, by Dr. Bowerbank. He finds "in the skeleton and in the form and disposition of the spiculæ, characters which, however Protean the form and color of the sponge may be, can always be recognized with certainty." Can the same means be made available for the extinct species? Obviously there will be many difficulties in the way, for in the latter we have to deal with the skeleton alone, modified by fossilization; whereas in the former all the structures are in a condition admitting of minute investigation. Nevertheless, very commonly, enough of the minute structure can be made out in the fossil to render it a most important means of discriminating the species. The external appearance is all but valueless for this purpose.

II. Prior to the time of D'Orbigny no attempt had been made to systematize the genera established by Lamoureux, Goldfuss, De Blainville, Michelin, Reuss, and others. M. D'Orbigny, however, conceiving that the fossil sponges had for the most part an organization entirely distinct from that of the recent species, divided De Blainville's class Amorphozoa, into two orders, viz., the *horny* and the *stony* sponges.

The former contained but a single genus, *Cliona*; the latter he subdivided into five families, based entirely upon external characters, viz.: 1, the *Ocellaridæ*; 2, the *Siphonidæ*; 3, the *Lymnoridæ*; 4, the *Sparsispongidæ*; and 5, the *Amorphospongidæ*. At the same time he proposed many new genera. These were constituted partly of species which had been distributed by his predecessors among genera established on recent forms by Lamarck and Schweigger, and adopted for fossil species by Dr. Goldfuss.

Pictet, and more lately De Fromentelle, have followed D'Orbigny in the view which he took respecting the stony character of the skeleton of the fossil sponges. The *Petrospongidæ* of Pictet, and the *Spongitaria* of the French author, correspond to the "*Amorphozoaires à squelette testacé*" of D'Orbigny. M. Etallon also entertains the same view. He includes among the fossil horny sponges none but the Clionidæ; and in speaking of the *Petrospongidæ* observes, that the skeleton is solid "like that of the Zoantharia, and formed doubtless in the same manner." In fact, nearly all the authors, with the exception of MM. Cappellini and Pagenstecher, appear to entertain similar views respecting the nature of the skeleton in this large group of fossil species. D'Orbigny and De Fromentelle maintained that the fossil sponges had originally a solid, unyielding skeleton. This opinion was partly based on the supposition that they would not otherwise have escaped compression, and partly on the circumstance that Polyzoa, Serpulæ, Ostreidæ, etc., frequently found attached parasitically to the surface of the sponge, have been observed to exhibit the worn appearance produced by the rolling of hard bodies on the sea bed. Moreover, they say that compressed specimens show more or less distinctly the signs of fracture. But while this may be true of some of those sponges that had a solid siliceous framework, it certainly is not generally the case, and examples of *Hippalimus*, *Ischadites*, *Morticria*, and many other sponges, more or less distorted by compression, are sufficiently abundant. That they should not—especially the cup-shaped sponges—be more often compressed than they are, may perhaps be a matter of surprise. But this is probably due to the circumstance that the fine muddy sediment in which they were entombed had so insinuated itself into the interspaces of the sponge as to afford an equal amount of support on all sides. [The compression often observed in fossils, especially those of the older rocks, is probably due to the squeezing to which they have been subjected in the change of position and contortion of the beds in which they occur, rather than to the dead weight of the superimposed sediment. It is now well known that starfish and other soft animals, even at the great depths of mid ocean, are not compressed, owing to the pressure being applied equally on all parts. Prof. Sars dredged sponges, actinozoa, true molluscs and worms at a depth of 300 fathoms, and the Swedish deep sea dredges, in the expedition to Spitzbergen, brought up crustacea, mollusca, and annelides at depths of from 6,000 to 8,400 feet. Quoted in the Intellectual Observer for Dec., 1866, p. 400, from Annals of Nat. History.] Moreover, some further explanation will suggest itself when speaking of the sponges of Farringdon, and the manner in which fossilization of the sponge appears to have often taken place.

Whether Polyzoa and other parasites are really more frequent on the fossil than on the recent sponge, is a question I am not prepared to answer. But M. De Fromentelle is certainly not correct in saying that they never occur upon recent sponges; and very frequently the adhesion of the parasites to the fossil sponge is more apparent than real, being produced solely by the cementing influence of fossilization, and by the nature of the matrix in which they are imbedded. In any case, unless the Polyzoa grew upon dead individuals, the nature of the skeleton could have had no influence upon the parasite, as, whatever it may have been, it was equally invested by the sarcode of the animal. That the serpulæ and ostreidæ sometimes become attached to the sponge while living is apparent from their having become partially embedded in the sponge tissue which has grown over them; but it is so also with recent sponges: and as regards the worn appearance of the parasites and other foreign bodies occasionally found attached to the sponge, it is quite possible that they may have undergone attrition before they became adherent; and, moreover, the fossil itself may have been derived from pre-existing deposits, as were the Oolitic forms found in the gravels of Farringdon.

But there is, in fact, no real ground for assuming with D'Orbigny and others that the skeleton of the fossil sponges was necessarily always solid and resisting, like that of the recent *Dactylocalyx*, Stucth, the *Farrea* of Bowerb., etc. Many of the siliceous sponges no doubt were so; but as regards the calcareous ones it may be observed that among recent species, according to Bowerbank, "carbonate of lime, as an element of the skeleton, is known only in the form of spicula." In some cases, as will be shown hereafter, the fibers or twigs were originally complex, formed of bundles of spicula, like the twigs in many of the recent species, and were afterward consolidated more or less completely by the fossilizing process. But there is no evidence that in others it may not have been keratose, either with or without the accessory spicula. Some of our recent horny sponges are not less resistant than the solid siliceous fibrous species, and are certainly less friable. In the fossil, however, the horny fiber is replaced by silica lime, or iron. That the tissue in the fossil is not identical with that of the original sponge, may be inferred from the circumstance that we commonly find all the sponges from one locality, or one deposit, in the same mineral condition. Thus, all those from the carboniferous limestone of the Great Orme's Head are silicified; but so also are the associate Zoophytes, Conchifera and Gasteropods, etc. All the sponges from the Farringdon green sand are calcareous, while those of Warminster are all siliceous. The sponges of the English Oolite are all calcareous: those of the chalk are either silicified or else in the state of moulds or casts, the walls of which are stained with peroxide of iron. [Both *Ischadites* and *Ptylospongia* occurred to Eichwald sometimes calcified, and sometimes converted into bisulphuret of iron, more or less peroxidized. His *Manon deforme* from Gherikoff, was silicified, while the examples of the same species from the environs of Poulkowa were all calcified. *Lethæa Rossica*, p. 339. *Ischadites Kœnigii* occurs in our British Upper Silurian rocks, both as a calcareous and a pyritized fossil.]

It has been thought that the iron staining of the moulds and their refilling with pyrites renders it probable that in the original sponge the fiber was keratose. That in the horny sponges pyritous casts may be more frequent than in the others is highly probable, but the amount of sulphur in the keratose is far too small to enter into combination with all the iron in the cast in accordance with the theory implied; and assuming that the original skeleton of the sponge was keratose, there is no reason to suppose that the mould would not be refilled in harmony with a general law, *i. e.*, the cast was siliceous when deposited from water, holding in solution silica rendered soluble by the presence of lime and alkalies; calcareous from waters holding lime in solution by the aid of an excess of carbonic acid; iron in other cases, and even bisulphuret of lead has been found replacing carbonaceous matter in the plant remains of the Lias of Dunraven. The manner in which the mould is refilled with silica was precisely similar to that by which it is made to replace the carbonate of lime in the tests of the mountain limestone mollusca of the Great Orme's Head, the Portland rocks of Tisbury, or the green sand of Blackdown. The Ostreidæ and Serpulæ, and other parasites attached to the surface of the Warminster sponges are frequently like the sponge tissue, in the condition of siliceous casts. As shown by Liebig, silica, when long in contact with lime in alkaline solutions, becomes soluble, and hence it is that we so often find the sponges of the chalk encased with silex, or with the interstices filled with a more or less porous mass of the same material, which is altogether adventitious to the sponge tissue. In a similar manner the mould may be refilled with carbonate of lime. On the other hand, an originally calcareous sponge may become converted into a siliceous fossil, as we see in the case of the mollusca of the Great Orme's Head and elsewhere, and that an interchange of this kind has actually taken place seems necessary to explain the fact that siliceous and calcareous sponges are not usually found associated in the same spot.

That the calcareous sponges, those of the English Oolites for instance, are merely casts of the original structure may be shown in another way. If, then, sections of the fibers may be made sufficiently translucent for the employment of a quarter-inch power of the microscope, it will be seen that the fiber has often the asbestiform structure radiating at right angles from a central axis, peculiarly a mineral arrangement, and especially of carbonate of lime. The structure of true sponge fiber on the contrary is concentric. The preservation of the sponge, therefore, in its fossil state, depends very much on the nature of the sediment in which it is embedded, and in the mode of its entombment. Hence they are met with but rarely in stiff argillaceous deposits; and although abundant in Mesozoic times, they are absent from all the clayey members of the series, such as the clays of the Lias, and the Oxford and Kimmeridge clays; yet they occur in continental beds of corresponding ages, but differing in lithological character. At the same time it is possible that the muddy waters of the seas in which these deposits were thrown down, may have been ill adapted to the well-being of the sponge, nevertheless they are met with in the Lingula Flags and in the Upper Silurian Shales.

The condition of the sponges of the gravel pits of Farringdon is remarkable, and may, perhaps, tend to throw some light on the mode in which fossilization of the sponge takes place in calcareous and such sandy deposits as contain lime, and help to explain, in some manner, the absence of compression in the fossil. Every twig of the sponge presenting a free surface throughout its entire thickness, is invested by a thin coating of minute dog-tooth crystals of carbonate of lime, forming a complete crust over the fiber, much in the same manner as moss, etc., is encrusted by a calcareous spring, These crystals seldom exceed $\frac{1}{750}$ of an inch in height, the average being about $\frac{1}{1000}$ of an inch, or even less; and on their surface they are slightly tinged by peroxide of iron. All the other fossils of the same locality are similarly coated with these minute crystals, even to the interior of the cells of the Polyzoa. When slightly acted upon by dilute acids, the crystalline layer is removed, and the cast of the sponge fiber exposed; but if this action of the acid be contained, the whole is dissolved usually without leaving any trace of siliceous spicula.

This sand and gravel, in which these fossils are embedded, are loosely cemented by carbonate of lime, and it is by no means certain at what period, after the sponges were entombed, this coating of crystals was deposited upon them. But it is quite possible that something similar to what has taken place in these Farringdon fossils may occasionally occur in other cases as a preliminary to fossilization, in consequence of the sponge, deprived of its sarcode, having long soaked in water charged with carbonate of lime.

The ordinary mode in which fossilization takes place, however, is in one of the two following ways: either the sponge after the destruction of its sarcode becomes infiltrated by fine sediment, which completely fills up the interstices and forms, as it were, a mould of the sponge skeleton, in which the fossilizing process takes place; or, the sponge is simply buried in the deposit, which forms a nidus about it, filling perhaps the tubules and oscular passages, or even the superficial parts of the tissue, but leaving the latter for the most part open and pervious, into which mineral matter is carried in solution and there deposited. The result of this may be, either to fill up the interspaces entirely, or merely to encrust and consolidate the fibers as in the sponges of the gravels of Farringdon; but in either case there is formed around the fiber or twig, a mould, in which the fossilization process takes place, which is the same precisely as that which is known to take place in fossils generally, viz., the removal of the original material of the skeleton, and its replacement by another. These changes are greater and more complete in proportion to the antiquity of the deposit in which the fossil occurs.

III. Pictet converted D'Orbigny's families into tribes, and introduced some additional genera created by Giebel, King, etc.; and, except in the description of new genera and species by Reuss, Roemer, Salter, Eichwald and others, the subject remained very much where D'Orbigny left it, until M. De Fromentelle proposed a new arrangement, based upon what he terms the "organs which serve for the nutrition of the sponge," viz., the tubule, oscules, pores, etc. Like D'Orbigny, he divides the sponges into two orders: 1st, the Spongiaria, which comprises only recent genera; and 2d, the Spongitaria, which contains all the fossil genera, with the exception of the doubtful group, the Clionidæ. The second order is further divided into three sub-orders: 1, those sponges which have one or more tubules (*the Spongitaria tubulosa*); 2, those that have oscules, but no tubule (*Spongitaria osculata*); and 3, those that have neither tubule nor oscules (*Spongitaria porosa*). Each of these sub-orders is further divided, thus: the tubular sponges into those in which the tubule is solitary, and those in which it is grouped, and also into those with oscules and those without oscules. The oscular sponges are similarly subdivided, according to form, disposition of the oscules, and presence or absence of an epitheca. Lastly, the porous sponges are divided into those that are more or less regularly cup-shaped, and those that assume some other form.

In this arrangement no importance is attached to the nature of the sponge tissue as a character. In fact, M. De Fromentelle states that he considers it to have "a value altogether secondary, for it is not the form or composition of the skeleton which determines the functions, but the functions themselves which give to the animal the particular form which characterizes it." It is not necessary, however, here to discuss this question, further than to observe, that the power which the sponge has to secrete a siliceous spicular framework in one case, or a fibrous rete in another, implies an inherent difference in the nature of the animal, however much they may resemble one another in external character. It will be desirable, therefore, to consider the value of these organs for a moment before proceeding further, and in so doing it will be well to draw on the living sponge for aid.

1. *Form.* As already observed, form, taken alone, is of little value even as a specific character, for whether it be cup-shaped, or tubular, or polymorphous, it is not distinctive, inasmuch as it is common to sponges widely differing in all other characters; and, indeed, as remarked by Dr. Bowerbank, trusting too implicitly to outward configuration has led to the placing of spicular and fibrous sponges side by side in the same genus. Moreover, the form varies greatly at different periods in the growth of the same individual; and even in the cup-shaped sponges, commonly the most constant as regards this character, there is a wide difference in the figure of the old and young individuals of the same species. Hence it is that we know so little of the young condition of many of the fossil sponges, which are not recognized as such, but are regarded, for the most part, as distinct species.

A circumstance which illustrates how the form of the sponge is liable to be governed by accident is mentioned by Dr. Bowerbank in speaking of their reproduction, and is so suggestive that I quote his own words: "On a fragment of a bivalve shell, twenty or thirty sponge gemmules had located themselves, the largest of which did not exceed $\frac{1}{300}$ of an inch in diameter, and their distance apart is about equal to their diameter. In their present state," says Dr. Bowerbank, "it is evident that they are separate developments; and it is equally evident that a slightly further amount of extension would have caused them to merge into one comparatively large flat surface of sponge. We see by this instance that a sponge is not always developed from a single ovum or gemmule, but, on the contrary, that many ova or gemmules are often concerned in the production of one large individual; and this fact may probably account for the comparatively very few small sponges that are found." Thus, the form of the sponge may be modified, in some instances, by the number of gemmules or ova that may happen to be grouped together, for it is well known that sponges of the same species readily unite when in contact.

It is necessary to bear these facts in view, for in most of the higher groups of life, whether living or extinct, variation in form is restricted to within very narrow limits, and therefore it is one of the most important characters we possess in the determination of the species. Nevertheless, even in the sponges it is not without a value, for in certain fossil genera the more matured individuals appear to be tolerably constant in this respect, as for instance the *Ventriculites*, *Ischadites*, *Guettardia*, etc., but at the same time the young condition of these genera are unknown to us, or, if so, have been regarded probably as altogether distinct; the youngest individuals which are recognized with certainty have already attained, comparatively speaking, considerable dimensions.

2. *The Cloaca.*—The cloaca or tubule may be either isolated or grouped. It may extend nearly the entire length of the sponge, or only a part of the way, as in *Siphonia.* It is distinguished from the oscules by its larger size, the evenness of its walls, and often by the orifices of the excurrent canals or oscules opening into it. The cloaca is essentially an ejaculatory passage, and in those fistulous sponges having oscules on the outer surface, these latter are the orifices of incurrent, not of excurrent, canals, and in the living sponges are sometimes protected by a diaphragm, formed of long, simple, slightly curved (acerate) spicula, but which would necessarily be lost in the fossil.

In the young sponge the cloaca is sometimes absent, as is often the case in the earlier period in the growth of *Siphonia pyriformis*, in which the place of the cloaca is occasionally found occupied by a group of small tubules, which ultimately either becomes converted into one large fistulous opening by the breaking down of the intervening tissue, or is surmounted by the true tubule. In its earlier condition, therefore, it presents the characters of *Jerea*, and only becomes converted into a veritable Siphonia as it approaches maturity. On the other hand, in old fistulous sponges, the margins of the cloaca sometimes break down and become fissured, and at length converted into an irregular cavity, in which it is difficult to recognize the characters of the original tubule.

3. *The Oscules.*—The oscules are the orifices of the incurrent and excurrent canals. By all authors who have written on the fossil sponges, however, they have been regarded solely in the light of ejaculatory

openings, but the study of the recent species has enabled Dr. Bowerbank to ascertain that this is not the case, and that in the tubular and cyathiform sponges, those only which open into the cavities appertain to efferent canals; while those situated on the exterior lead into the canals which are destined to give passage to the incurrent streams of nutritive fluid. In all the tubular and cup-shaped sponges, therefore, their office may be inferred by their position. In the amorphous sponges they are scattered over the surface either singly or in groups, sometimes on mamillary elevations or ridges, sometimes in pits or depressions, and are probably ejaculatory orifices, imbibition taking place through the pores and interstices of the sponge skeleton. They are permanent organs, and vary greatly in size, proximity, and regularity in their distribution. Occasionally several grooves radiate from the margin of the oscule, and in other species there is no distinct orifice, but the grooves terminate internally in three or four small pores, which then supply the place of the single oscule; but even these are sometimes scarcely perceptible, as in the Silurian *Stromatopora* (*Stellispongia*) *constellata* (Hall). These stellate grooves, or "*Sillons*," are not, however, physiologically distinct from the oscules; and the smaller grouped tubules, as for instance those in *Jerea* (*Polypothecia*) *dichotoma* (Bennett), and *J. pyriformis* (Lamour), etc., do not differ from oscules, except in their greater length.

4. *The Pores.*—Besides the oscules, paleontological writers are in the habit of speaking of the pores. It must be understood, however, that by this term they designate not the temporary openings in the sarcode of the animal during imbibition, to which it is properly applied, but merely the interstices in the tissue of the skeleton in the dead sponge; for in the living state these interstices are more or less completely filled with the sarcode. In some sponges there are no orifices, either of incurrent or excurrent canals, that are distinguishable either by form, size, or position, from the ordinary interstices of the sponge tissue, the whole being formed of a nearly uniform rete; and in these cases the pores or interstices must supply the place of the larger orifices, although closed by the sarcode during the intervals of active inhalation and exhalation; moreover, in those sponges possessing well marked incurrent orifices it is still probable that the whole of the external surface is more or less an inhalent one, through the interspaces of the rete, according to the exigencies of the animal.

5. *The Epitheca.*—Among the fossil sponges some portion of the surface, especially externally, toward the base, is frequently observed to be either without pores or they are so minute as to be invisible, and the sponge then appears as though covered by a more or less smooth

or slightly wrinkled membrane, which has been regarded by D'Orbigny, De Fromentelle, F. A. Roemer, and others, as analagous to the epitheca of the Zoantharia; and the occurrence of this epitheca has been held to be an additional evidence of the stony nature of the sponge skeleton. When examined microscopically, by means of thin sections, however, it appears that this epitheca is due to the filling up of the interstices of the superficial parts of the sponge, which in the situations in which it exists is finer and more condensed than elsewhere. This greater density of the surface may be seen in many recent sponges, the superficial portions of the tissues being closer and finer than that of the interior, which was formed during an earlier and more active period in the growth of the sponge. But either from having arrived at maturity, or at a period when the growth was temporarily arrested, for in some sponges the growth is intermittent, or, as appears sometimes to be the case, from some local cause, the tissue at the surface assumes a closer arrangement. Thus, in the common *Halichondria panicea*, the surface over greater or less portions frequently presents a condensed appearance, with scarcely any visible interspaces, the outer superficial portion being made up of a densely matted layer of spicula, placed for the most part parallel to the surface; and the same is true of many fibrous sponges, as shown by Dr. Bowerbank. In some of the fossil sponges a similar modification of the tissue at the surface appears to have obtained, especially in certain cup-shaped and cylindrical sponges, and in the calcareous fossils in which this has been the case, the interstices, from their extreme minuteness, are more or less filled with carbonate of lime. Thus, a species of *Cupulospongia*, common in the gravel pits of Farringdon, frequently presents on its interior a smooth surface, described by the late Daniel Sharp as a membrane. But if a number of individuals of this species be examined, it will be observed that although it sometimes completely lines the interior of the cup, it more often only occurs in patches; and that while some of the interstices are blocked up, there are others that remain open, and this not as the consequence of friction or weathering, but as the result of fossilization. It is, however, in some of the sponges of the Oolite that we see this infilling of the interstices most distinctly, in some of the cylindrical forms especially, the whole of the sponge, except its summit, appearing as though invested by a sheath, but which, were it really of the nature of a true epitheca, as the Zoantharia, it would be difficult to comprehend how the functions of the animal were carried on. [It is not here necessary to discuss the question of a "dermal membrane," as this would of course perish with the sarcode, and about which, moreover, some difference of opinion appears to exist, the facility with which the pores open and close, to admit or check the incurrent streams of water, and the readiness with which the sarcodal mass is repaired after injury, and unites on contact with that of another individual of the same species, are facts which have been held to militate against the possession of such a structure. That the supporting tissue in certain recent species becomes closer and otherwise modified at the surface is clearly ascertained, and in some species there is a crusticular layer of embedded ovaries, abounding in minute spicula, beneath the surface of the sarcode. There is likewise a sponge common on the coast at Tenby, in which, in some individuals, the base and for a little distance above it does appear, in the dried condition, to be invested by something like a membrane, which terminates upward in a well defined and thickened or slightly wrinkled margin; the kerato-spicular tissue of the sponge immediately beneath it is more densely reticulated than in other parts of the animal; but I was unable to satisfy myself that it constituted a true membrane as distinct from the sarcode. That this soft structure may, under favorable circumstances, so impress the mould of the fossil as to produce the appearance described as an epitheca, may be possible; but this is altogether different from the Sclerotic sheath which invests the exterior in the Zoantharia.] It is more than probable that this structure is nothing more than the cast of the impression or mould of the outer surface of the sarcode of the sponge, perhaps slightly thickened, but it is not constantly present even in the same species. For example, there is a small cylindrical sponge, not infrequent in the Coral Rag at Bullington Green, near Oxford, in which more or less of this so-called epitheca is met with in some individuals, while the greater number show nothing of the kind. It appears, therefore, that the epitheca is sometimes only a result of fossilization, and is sometimes probably the cast of the outer surface of the sarcode which has left its impress on the mould; that it is absent in the earlier and growing stages of the sponge, and is not constantly present in the matured individuals of those species in which it occurs; and, moreover, that it sometimes results from the contact of foreign bodies, in consequence of the increased density of tissue which such bodies are apt to produce. Its value, therefore, even as a specific character, is not great.

Simple as DeFromentelle's arrangement may at first sight appear, it is open to the objection that it is based upon characters that are not always very constant, or very well defined, and are liable to graduate from one into another. Moreover, it unites in one genus or species individuals which, having a very close similarity in external appearance, are totally different in the organization of the skeleton, and, on the other hand, it separates others, which, though differing in outward characters, are closely allied in their structural details; for, however great may be the similarity in form or disposition of the oscules, etc., the power to secrete a framework composed of spicula in one case, or entirely fibrous in another, appears to indicate a difference in the nature of the sarcodal mass of higher importance than mere outward configuration, which we know from the study of recent species is frequently subject to considerable variation, either from age, local peculiarities, or other circumstances. Thus Dr. Bowerbank, in illustration of the amount of variation observable in recent sponges, refers to our common British *Halichondria panicea*, which, when of small size, has the oscules "situated on the surface of the sponge, and are scarcely, if at all, elevated above the dermal surface; while in large specimens of the same species we find them collected in the inside of elongated tubular projections or common cloaca, which vary from a few lines only in height and diameter to tubular projections several inches in height, with an internal diameter of half or three quarters of an inch. When they attain such dimensions, their parieties are often of considerable thickness and their external surface becomes an inhalent one, like the body of the sponge." [Here we have an example of an oscule passing into a cloaca as age advanced, and an amorphous sponge becoming a fistulous one.]

IV. About the same time that M. de Fromentelle's Memoir appeared in the Transactions of the Linnæan Society of Normandy. M. Etallon communicated to the Society Jurassiene some papers on the sponges of the Upper Jurassic rocks, in which he proposed a new arrangement of the species and genera, based on the structural details of the skeleton. As he treats only on those fossil sponges which belong to the Upper Jura, his classification is necessarily incomplete; but it is, nevertheless, sufficiently so to foreshadow his views on the subject generally. Like D'Orbigny, he regarded the *Clionidæ* as horny sponges, and forms them into an order by themselves; while the testaceous sponges, included in the *Petrospongidæ* of M. Pictet, he divides into orders—1st, the *Dictyonocœlidæ* or spicule-bearing sponges, and 2d, the *Spongiaires vermicules*, or true *Petrospongidæ*. [The *Clionidæ* are, however, only the accidental occupants of the cavities in which they are found, having located themselves in the excavations formed by Annelidæ and the terebrating mollusks. For the most part they are spicular sponges.]

With respect to the first of these groups, M. Etallon observes: "There are among the testaceous sponges, which do not enter into the family of *Petrospongidæ*, some that have their skeleton made up of little needle-shaped spicula, which are merely held together by the parenchymas or sarcode of the animal, and of which, in certain formations, we find the scattered remains; but in other species these needle-shaped spicula are always anastomosed, so as to form little stars, united together by the extremities of their rays." It is to this group that he gives the name of *Dictyonocœlidæ*, and he describes these stellate spicula as being formed by the enlargement of the two extremities of a slender cylindrical spicula, which thereby becomes cone-shaped at the end, and unite, by the circumference of their base, with neighboring cones, to form a six-rayed spicula with a central noeud; and in the center of this knot or noeud M. Etallon believes that there exists a cubic space, which is subdivided by vertical and horizontal laminæ placed in the axis of the rays into eight chambers. There results from this arrangement a framework composed of horizontal, vertical, and radiating rods, having a knot at their point of intersection, and this eight-chambered noeud may be regarded as standing in the place of the octohedral structure of Mr. Toulmin Smith.

While agreeing with M. Etallon, that there are certain sponges constructed on a general plan of intersecting horizontal, vertical, and radiating rods, a plan, indeed, which still obtains at the present day, the writer is far from admitting that this is the ordinary plan on which the spicular sponges are organized, and he has entirely failed to detect any trace of that subdivision of the cavity of the noeud into the eight cubic chambers described by M. Etallon. [In some stellate spicula, probably in all, at the point where the central canals of the rays unite in the noeud, there is an hexagonal space, as noticed by this author, but the appearance of vertical and horizontal laminæ are referable to an optical effect of light.] Moreover, the manner in which it is suggested that the skeleton is made up—for as its development can not be traced in the fossil, it can be nothing more than a suggestion—is altogether opposed to what we know of the growth of spicula in general; and the study of the recent siliceous and calcareous sponges gives no countenance to the supposition that radiating spicula are formed by the union of the rays. On the contrary, as observed by Dr. Bowerbank, "however closely the spicula may be brought into contact with each other, or with siliceous fiber, they do not appear to unite or anastomose, while fiber, whether siliceous or horny, always anastomoses when it comes into contact with parts of its own body, or of those of its own species." The growth of the sponge tissue is outward, not interstitial, and the parts once formed and fully developed undergo no further change. Judging from analogy, the development of the spiculum always proceeds from the center, and growth takes place by additions to the thickness of the rays and at the points, and the occurrence of radiate spicula in the same individual sponge of all sizes, from the matured condition down to extreme smallness, always preserving the radiate form, is entirely against the view of M. Etallon. If union ever takes place, it is probably the result of fossilization, in cases where the points of the rays are in contact, and it is then brought about, probably, either by adventitious deposit or in the replacement of the original structure—the mineral which has infilled the mould has run together.

Nevertheless, the labors of M. Etallon are a move in the right direction, and it appears probable from his research, that by a careful investigation of the structural details of the fossil sponges, it may be possible ultimately to arrive at results which may lead to an arrangement of the species and genera more suited to the requirements of the day than the artificial systems of D'Orbigny and DeFromentelle. The time, however, is probably not yet come for this to be attempted, the more especially as the arrangement of the recent species is far from being settled.

V. Two conclusions are suggested by the foregoing remarks: 1st, that the present state of the fossil sponges afford no certain indication of their condition during life; and 2d, that in the differentiation of the genera and species the same principles must be kept in view in the fossil as in the recent sponge. Some of the oldest fossil sponges were as highly organized, apparently (if the term is admissable to these humble forms of life), as those of the present day, as for instance *Protospongia* of the Lingula Flags and Ludlow Rocks, the Silurian *Ischadites*, and the Devonian *Sphærospongia tesserata*. The *Protospongia*, in fact, belong to that general type of Cyathiform sponges, formed of elongated, vertical, and horizontal rods or fibers, which become more abundant in the Oolitic and Cretaceous rocks, and have their representatives even in the present day.

The Amorphospongidæ first make their appearance in the Silurian rocks, and occur more or less abundantly in the calcareous marine deposits of all the succeeding epochs; and species are still living in our present seas, for which, as far as external appearances are concerned, at any rate, it is difficult to find good distinctive characters. The cup-shaped and cylindrical forms of this group commence in the Devonian and carboniferous limestones, and in the *Mortiera vertebralis* (De Konninck), we have a depressed form of the latter, which, in the mountain limestone (?) of India attained greater vertical development. There are recent forms, which, to all appearances, are undistinguishable either in figure or in the texture of the rete, and the only appreciable difference that can exist must be in the structure of the fiber. *Sipho-*

nia pyriformis is apparently a still living species, well preserved specimens from Blackdown, presenting no external character to distinguish them from the recent form, nor with certainty do its structural details. The Warminster specimens are seldom well preserved; but in the flints of the chalk thin sections sometimes show the spicular structure of the cords, of which the skeleton of the sponge is chiefly composed.

All the fossil sponges, exclusive of those masses of scattered spicula found in the mountain limestone chert of the Great Orme's Head, the Lias of Glamorganshire, or the flints of the chalk, etc., appear to be capable of being arranged in four groups, having a common character, viz.: 1st, those in which the skeleton is built up, mainly of fibers or elongated spicula, which cross each other more or less at right angles, but which in the cylindrical forms of this group assume in part a radiating arrangement; 2d, those in which it is constituted of variously formed spicula, heterogeneously arranged; 3d, those in which the skeleton consists of a rete, the cords of which are formed of spicula; and 4th, those formed of a rete of fibers in which spicula, if present, were only accessory, and which, judging from the general structure of the fabric, were probably keratose or horny sponges. No doubt the first two groups trench upon each other, in so far that the rectangular structure is frequently accompanied by accessory stellate, and other spicula; and the last two may be often difficult to differentiate, in consequence of the structure not being sufficiently well preserved. These, however, are difficulties which the paleontologist has to contend with constantly, and which it is his object, with time and opportunities, to remove. Many a fossil conchifer has been moved from genus to genus, until the structure of its hinge was ascertained; many a mollusk is still uncertain as regards its affinities to existing genera. But on their relation to existing genera and species, which can be arrived at only by patient inquiry into structural details microscopically, by means of thin sections or otherwise, can the differentiation of the fossil spongiadæ be satisfactorily made. Occasionally the structure, especially in the silicified sponges, is so admirably prepared as to render this not difficult; but until their true affinities to recent species have been studied from a *strictly zoological* point of view, our knowledge concerning them must be wanting in scientific precision. The result of such inquiries will probably be to reduce many genera to the lower grade of species, and many species to mere varieties or conditions of growth. In common with other forms, equally low in the scale of organization, the sponges appear to have endured through a long range of time, subject only to modifications, which scarcely amount to specific distinctions.

Geological Survey of Illinois, Prairies, etc.

The fifth volume of the geological survey of the State of Illinois, for ability displayed, excellence of engravings, and neatness and correctness in the execution of the work, has not been surpassed, if it has even been equaled, by any other publication on the science of geology in the United States.

The first 300 pages of the volume are devoted to a general geological description of a few counties. The next 300 pages contain paleontological descriptions of invertebrates from the carboniferous rocks, which are beautifully engraved on 32 lithographic plates at the end of the volume.

The following, from the preliminary chapter upon the causes which led to the formation of the great prairies of that State, is quite interesting:

"The largest portion of this part of the State is prairie land. In it all kinds of prairies may be seen, such as the high upland prairies, the river bottoms or alluvial prairies, and the low, wet swamp lands. There is quite a diversity of opinion as to the origin and formation of these treeless and grass-covered regions of the Northwest. One theory attributes them to annual fires sweeping through the grass, and killing every tree germ and young tree almost before they could take root. In some places the fires are supposed to have encroached, year by year, upon the forests; in other places, as for instance along the streams, in the deep hollows, or in wet places, where the fires would be checked, the timber would spring up and displace the prairies. Another theory accounts for the treeless character of these plains from the lacustine origin and nature of the prairie soils and subsoils. Trees will not naturally grow in this sedimentary, finely comminuted prairie soil according to this theory. Others attempt to explain prairie phenomena by atmospheric and climatic influences, marking out certain zones of moisture and dryness. They bound forest and prairies by certain isothermal lines. Another theory, advocated with force and plausibility by Professor Lesquereux, in the first volume of the geological reports of this State, finds all our prairies to originate from causes similar to those which form peat beds, and are in fact incipient peat beds, drained before completed. In his own clear language, he finds "that all the prairies of the Mississippi valley have been formed by the slow recession of sheets of water of various extent, first transformed into swamps, and by-and-by drained and dried. The high, rolling prairies, the prairies around the lakes, those of the bottoms along the rivers, are all the result of the same causes, and form a whole in an individual system." No one of these theories is sufficient to explain all the phenomena noticed in making an examination of the prairies. As in most such cases in theoretical geology, all of them perhaps contain some truth, and may be applicable to localities more or less extended. The burning of the forests, in a few cases, doubtless, has changed timber into prairie land, and prevented the timber from invading small tracts of the prairies. But the sweeping, consuming autumnal prairie fires are not sufficient to account for the origin of our wide prairies, else prairies would be found scattered through all the timbered regions of the continent. Neither is atmospheric causes sufficient, for the observations of meteorologists show the annual precipitation of moisture, in the form of rains, over our northwestern prairies, quite as evenly and extensively as in the timbered regions of the eastern and northern parts of the continent. The chief causes of the treeless character of our prairies are undoubtedly found in the soil itself.

It is very true that trees, even those whose native habitats seem to be the damp alluvial soils of our river banks, will flourish and grow when planted upon the prairies; but the artificial process of planting seems to fit the soil for their reception. Even vines, Indian corn, and many other sorts of vegetation, will flourish when thus artificially planted, but never would grow naturally and of their own accord upon the grass-bound prairie sod. The prairie soil is naturally adapted to the growth of prairie grasses, and the prairie grasses not only resist the growth of trees, but actually kill them out. By destroying the grasses and sods and cultivating the trees, they will grow vigorously. The prairie soil has certain antiseptic properties, and ulmic and other acids, which give it a sourness. The prairie grasses naturally flourish in such a soil. These properties in the soil, and these grasses, are all unfavorable to the growth of trees; and it is only when their influences are counteracted by cultivation, or other local causes, that trees will grow in health and vigor. Cultivation does destroy this sourness in the soil; and I believe that if all the cultivated prairies of the State were suffered to relapse into uncultivated wastes, instead of going back to their prairie condition, they would become eventually covered with brambles, thickets, and growths of timber.

In this part of the State, along the Mississippi, Rock river, and other streams, much of the alluvial bottom subject to annual overflow is covered with timber. There are, however, alluvial prairies along these streams timberless, and for the most part sandy and coarse-grained, and entirely different in composition and texture from the usual Illinois upland prairie.

The swamp lands of Whiteside, Lee, and Carroll counties afford a fine illustration of Professor Lesquereux's theory of the gradual transformation of swampy, boggy ponds, marshes and swales, into the black, spongy moulds of our richest prairies. Aquatic vegetation, the gradual encroachment of the land into ponds, the slow drying of our wet lands, and the gradual filling up of the ponds by successive growths and decays of aquatic vegetation, is building up rapidly sour-soiled, treeless prairies. The processes are similar to those forming the peat beds. The results of the processes are curtailed and modified, and a peaty-soiled prairie is formed instead of a bog or bed of peat.

But the high rolling prairies of Carroll, Stephenson, Winnebago, and parts of Ogle and Whiteside counties, with, in many instances, but thin soils covering the coarser drift materials below, do not show so plainly the same sort of originating causes. They are interspersed with numerous small groves of timber. These grow along the alluvial mixed soil of the streams, and upon the ridges and patches thrown up and beat together by the waves and currents of the broad, lake-like expanse of water, which covered this part of the State immediately subsequent to the glacial ice period. A few of these drift ridges, as in northwestern Ogle county, are treeless, owing perhaps to fires, or other local causes.

Excessive humidity of these high rolling, somewhat sandy prairies does not exist, and can not satisfactorily account for their treeless character. Neither do they bear in their soils and subsoils the evidence of having once been swampy, marshy plains.

When the waters of the broad, shallow, fresh water sea, once extending south and west of Lake Michigan, were slowly drained off, either by the breaking away of southern water barriers, or the slow upheaval of this whole region, parts of the bottom were undoubtedly left as broad marshes, swales and bogs, which assumed in due course of time a peaty character; but other parts must have been left comparatively dry, and covered, with the fine impalpable sediment, constituting the basis of our present prairie soils. The swamp and peat lands of Lee, Whiteside, and Carroll counties afford fine examples of the former condition of things; the rolling, drier, sandier prairies of Stephenson, Winnebago, and parts of Carroll and Ogle counties, afford just as fine illustrations of the latter condition of things, while Boone county exhibits very plainly both.

The treeless nature of the marshes is very satisfactorily accounted for upon Professor Lesquereux's theory of the origin of the prairies. The treeless character of the high prairies must be accounted for by the nature of the soil itself; the natural tendency of an herbaceous, rather than of an arboreal vegetation, to gain and keep possession of the prairie soil, aided perhaps by fires and other local causes.

These views of mine may contain erroneous suggestions. I have had no special means to examine soils, or compare wide extents of prairie regions with each other. I arrive at my own conclusions from simple observations of the prairies in this part of the State. I am satisfied that no one theory yet advanced, as to the origin and formation of the prairies, will account for all their phenomena, even in this limited portion of the State. Combined causes, operating with different degrees of force, in different parts of the great prairie regions of the country—sometimes one cause predominating, sometimes another, and sometimes all together—are more in harmony, it seems to me, with the effects left for our observation.

Definition of Species.

Wallace says: "In estimating these numbers *(of Papilionidæ)* I have had the usual difficulty to encounter, of determining what to consider species and what varieties. The Malayan region, consisting of a large number of islands of generally great antiquity, possesses, compared to its actual area, a great number of distinct forms, often, indeed, distinguished by very slight characters, but in most cases so constant in large series of specimens, and so easily separable from each other, that I know not on what principle we can refuse to give them the name and rank of species. One of the best and most orthodox definitions is that of Pritchard, the great ethnologist, who says, that '*separate origin and distinctness of race, evinced by a constant transmission of some characteristic peculiarity of organization*' constitutes a species. Now, leaving out the question of 'origin,' which we can not determine, and taking only the proof of separate origin, '*the constant transmission of some characteristic peculiarity of organization,*' we have a definition which will compel us to neglect altogether the amount of difference between any two forms, and to consider only whether the differences that present themselves are *permanent.* The rule, therefore, I have endeavored to adopt is, that when the difference between two forms inhabiting separate areas seems quite constant, when it can be defined in words, and when it is not confined to a single peculiarity only, I have considered such forms to be species. When, however, the individuals of each locality vary among themselves, so as to cause the distinctions between the two forms to become inconsiderable and indefinite, or where the differences, though constant, are confined to one particular only, such as size, tint, or a single point of difference in marking or in outline, I class one of the forms as a variety of the other.

"I find as a general rule that the constancy of species is in an inverse ratio to their range. Those which are confined to one or two islands are generally very constant. When they extend to many islands, considerable variability appears; and when they have an extensive range over a large part of the archipelago, the amount of unstable variation is very large. These facts are explicable on Mr. Darwin's principles. When a species exists over a wide area, it must have had, and probably still possesses, great powers of dispersion. Under the different conditions of existence in various portions of its area, different variations from the type would be selected, and, were they completely isolated, would soon become distinctly modified forms; but this process is checked by the dispersive powers of the whole species, which leads to the more or less frequent intermixture of the incipient varieties, which thus become irregular and unstable. Where, however, a species has a limited range, it indicates less active powers of dispersion, and the process of modification under changed conditions is less interfered with. The species will, therefore, exist under one or more permanent forms, according as portions of it have been isolated at a more or less remote period." [Wallace on Natural Selection, page 141.]

Mr. Darwin, in his summary to chap. 2, p. 67, of his "Origin of Species," says:

"Varieties can not be distinguished from species except—first, by the discovery of intermediate linking forms; and secondly, by a certain indefinite amount of difference between them; for two forms, if differing very little, are generally ranked as varieties, notwithstanding that they can not be closely connected; but the amount of difference considered necessary to give to any two forms the rank of species can not be defined. In genera having more than the average number of species in any country, the species of these genera have more than the average number of varieties. In large genera species are apt to be closely, but unequally, allied together, forming little clusters around certain other species. Species very closely allied to other species apparently have restricted ranges. In all these several respects the species of large genera present a strong analogy with varieties. And we can clearly understand these analogies if species once existed as varieties, and thus originated; whereas these analogies are utterly inexplicable if species are independent creations.

It is the most flourishing or dominant species of the larger genera within each class which on an average yield the greatest number of varieties; and varieties tend to become converted into new and distinct species. Thus, the larger genera tend to become larger; and throughout nature the forms of life which are now dominant tend to become still more dominant, by leaving many modified and dominant descendants. But, by steps the larger genera also tend to break up into smaller genera. And thus the forms of life throughout the universe become divided into groups subordinate to groups."

The Late Professor Louis Agassiz.

[From Harpers' Weekly, January 24, 1874.]

Few events during the year 1873 have created a more profound impression in the United States than the decease of Professor Louis Agassiz. He was born in the parish of Mottier, near Lake Neuchâtel, Switzerland, in May, 1807, and at a very early age developed a taste for scientific pursuits. His studies were prosecuted at the colleges of Lausanne and Zurich, as well as at the universities of Heidelberg and Munich.

His earliest special work was that upon the fishes of Brazil, as collected by Von Martius. Next to this came "The Natural History of the Fresh-water Fishes of Europe," which, as far as published, had special reference to the *Salmonidæ*, and upon which it is still a principal authority. He was best known, however, during his residence in Europe in connection with his researches upon the fossil fishes, and those upon the characteristics and conditions of the glaciers of Switzerland and other countries, and the detection of traces of past glacial action in different portions of Europe. Other important works published in Europe are the "Memoirs on the Casts of Mollusks," the "Monographs of Echinoderms," the "Nomenclator Zoologicus," and the "Bibliographia Zoologiæ."

In 1846 Professor Agassiz visited the United States, at the expense of the King of Prussia, for the purpose, primarily, of making himself familiar with the natural history and geology of the country, and also to deliver a course of lectures at the Lowell Institute, Boston. On his arrival in this country he found so rich a field for scientific inquiry that he concluded to remain permanently, and in 1848 accepted an invitation to become a member of Harvard University. Shortly after this he proceeded on a tour to Lake Superior with some of his students, the results of which are embodied in an octavo volume, entitled: "Lake Superior: its Physical Character, Vegetation, and Animals, compared with those of other and similar Regions."

One of the earliest papers published by him in the United States was "The Classification of Insects from Embryonical Data," printed by the Smithsonian Institution, in its "Contributions to Knowledge," in 1850. His most voluminous work was entitled "Contributions to the

Natural History of the United States," of which four quarto volumes have appeared, devoted principally to the turtles and radiates. "The Principles of Zoology," prepared conjointly with Dr. A. A. Gould, of Boston, was for a long time used as a text-book in the schools of the United States. The proceedings of the societies and associations in Boston and elsewhere, and the volumes of the "American Journal of Science," and other scientific and literary serials, contain numerous articles of greater or less magnitude from his pen. He also furnished important contributions to various works by other authors, as to Nott-Gliddon's "Types of Mankind," etc.

In 1865 Professor Agassiz made a visit to Brazil, at the expense of Mr. Nathaniel Thayer, an account of which was published in a handsome volume in 1867. In November, 1871, he started on a voyage round Cape Horn in the United States Coast Survey steamer Hassler, reaching California in the summer of 1872.

During the whole period of his residence in this country, Professor Agassiz was diligently occupied in collecting materials with which to enrich what he was determined should be the most complete and best appointed museum of natural history in the world, and at the time of his death he had measurably accomplished his purpose. Numerous expeditions were made by him for the purpose of gathering zoological objects, and collectors were dispatched to or engaged in various portions of the world with the same intention. These, with spontaneous contributions from all directions, brought a continued influx of material to Cambridge. The expedition to Brazil, and that around Cape Horn in the Hassler, were greatly productive; to such an extent, indeed, as to require a considerable time yet to come before the material can all be properly assorted.

The intensity of Professor Agassiz's labors had naturally the effect of injuring his health, and for some years past his physicians have insisted upon a relaxation; but so powerful were the temptations that it was almost impossible to prevent his going beyond his strength. His voyages to Brazil and around Cape Horn to California were of eminent service to him, and his friends had strong hopes for the future; but it is probable that the labors consequent upon the establishment of the Penikese Summer School of Natural History had a great influence in the final breaking down of his health.

Much restored by a short vacation spent at the White Mountains, on his return to Cambridge he entered upon his duties connected with the museum of comparative zoology with renewed zeal; and, probably in consequence of exposure in this connection, he was taken ill, and died at 10.15 P.M., Sunday, December 14, at the age of sixty-seven, universally lamented.

He was in constant receipt of communications from all parts of the country in reference to matters of science or curiosity, and however inappropriate to his specialties, an appeal to "Professor Agassiz" was supposed to be all that was necessary to settle any question. This, of course, drew upon him a great deal of labor in the way of correspondence, which must have been extremely burdensome.

The School of Natural History which was established by him in connection with Harvard College had a great influence upon the scientific development of the country, and a large number of his pupils are now exercising the function of teachers elsewhere, or either are of have been engaged in important original investigations. Among those who may be especially mentioned in this connection are Professor A. E. Verrill, of Yale College, Dr. William Stimpson, Professor A. Hyatt, Professor N. S. Shaler, Mr. F. W. Putnam, Mr. J. A. Allen, Colonel Theodore Lyman, his son Alexander Agassiz, Professor Henry James Clark, Dr. Charles Girard, and others.

The great range of Professor Agassiz's studies and acquirements, embracing nearly every department of science, enabled him to appreciate most thoroughly their mutual bearings; and it was seldom, indeed, that in any scientific gathering a communication was made on any subject which he was not able to discuss and to illumine, and in many instances to establish important generalizations from facts which had previously seemed isolated and of no special meaning. With all this, however, he was extremely modest in regard to his own acquirements, and was accustomed to say that all he felt he could claim, as constituting any special merit on his part, was the generalization that the successive appearance of life in geological times is essentially represented and illustrated by the successive changes of embryological development at the present day.

Any account of the scientific as well as the personal history of Professor Agassiz is incomplete that does not mention Mrs. Agassiz. To her especially does the world owe the publication of his essays, lectures, and many special works, which in most instances were written out and in large part prepared for publication by her. The companion of all his journeys, she was ever by his side to take down from his lips the utterances of the master mind, and, by her thorough sympathy in all his pursuits, and her great business and social qualifications, able to relieve him from many duties that would have wasted time belonging to the world at large, at the same time warning off with sleepless vigilance aught that might tend to injure his health.

CONSTITUTION

OF THE

CINCINNATI SOCIETY OF NATURAL HISTORY.

ARTICLE I.

The society shall be called the Cincinnati Society of Natural History.

ARTICLE II.

It shall consist of resident members, corresponding and honorary members, and patrons.

ARTICLE III.

All members shall be chosen by ballot after having been nominated at a preceding meeting. The affirmative votes of three fourths of the members present shall be necessary to a choice. The nomination of corresponding and honorary members shall proceed from the council. Any person who shall contribute at one time to the funds of the society a sum not less than one hundred dollars, shall be a patron. Any resident member who shall at one time contribute one hundred dollars to the funds of the society, shall be considered a life member, free from assessment.

ARTICLE IV.

Resident members only shall be entitled to vote, to hold office, or to transact business. Corresponding and honorary members and patrons may attend the meetings and take part in the scientific discussions of the society.

ARTICLE V.

The officers of the society shall be a president, two vice-presidents, a corresponding secretary, a recording secretary, a treasurer, a librarian, a custodian, and curators, who together shall form a board for the management of the concerns of the society, and be called the council.

ARTICLE VI.

Officers shall be chosen by ballot, and a majority of votes shall be sufficient for a choice.

ARTICLE VII.

By-laws for the more particular regulation of the society shall from time to time be made.

ARTICLE VIII.

The constitution may be altered or amended in any of the preceding articles by a vote to that effect of three fourths of the members present at any two consecutive meetings of the society, the members having been first duly notified of any proposed alteration, but the article which immediately follows this shall be unalterable.

ARTICLE IX.

The consent of every member shall be necessary to a dissolution of the society. In case of a dissolution the property of the society shall not be distributed among the members of the society, but donors may claim and receive such donations as they have made to the museum, and the remainder shall be given to some public institution, on such conditions as may then be agreed on, and the faithful performance of such conditions shall be secured by bonds with sufficient penalties for the non-fulfillment thereof.

BY-LAWS.

ARTICLE I.—OF MEMBERS.

SECTION 1. Any person of respectable character and attainments residing in the city of Cincinnati, or its immediate neighborhood, shall be eligible as a resident member of the society. Elections shall be held at the regular meetings of the society. Nominations must be made in writing, by three members, at least one month previous to the time of elections. Such nominations shall be made to a committee, consisting of the president, recording secretary and treasurer, who shall report upon the same before balloting. Every person elected shall, within six months from the date of his election, pay into the treasury an initiation fee of five dollars, and subscribe an obligation promising to conform to the constitution and by-laws of the society; and, until these conditions are fulfilled, he shall possess none of the rights of membership, nor shall his name be borne upon the roll of members.

SEC. 2. Corresponding members shall consist of persons residing at a distance from the city who may be interested in the study of natural history, or desirous of promoting the interests of the society. Honorary members may be selected from persons eminent for their attainments in science, on whom the society may wish to confer a compliment of respect. Neither shall be required to pay an initiation fee or contribution.

SEC. 3. Persons who have been unsuccessful candidates for admission shall not be again proposed as members until after one year.

SEC. 4. Any member may withdraw from the society by giving written notice of his intention, and paying all arrearages due from him. Any member who shall neglect to pay his dues during the year for which the same are payable, upon being notified by the treasurer at the end of the year, and not paying within one month thereafter, shall forfeit membership.

SEC. 5. Members may be expelled from the society by a vote of three fourths of the members present at a stated meeting, by a notice given at least one month previous.

ARTICLE II.—OF OFFICERS AND THEIR DUTIES.

SECTION 1. The president shall preside at meetings of the society and of the council, shall preserve order, regulate debates, and conduct all business proceedings.

SEC. 2. The vice-presidents shall perform the duties of president in his absence, in the order of seniority in office.

SEC. 3. The corresponding secretary shall conduct the correspondence of the society and shall keep a record thereof, shall keep the common seal, acknowledge all donations, notify corresponding members of their election, and receive and read to the society all communications which may be addressed to him.

SEC. 4. The recording secretary shall take and preserve correct minutes of the proceedings of the society and council, in books to be kept for that purpose, shall have the charge of all records belonging to the society, shall notify resident members of their election, and committees of their appointment, shall call special meetings when directed by the president, and shall notify resident members of all meetings, and officers of all matters which shall occur at any meeting requiring their action.

SEC. 5. The treasurer shall have charge of all money and other property of the society, excepting the museum and its contents, and excepting also such property as may be placed by the council in the hands of trustees, shall collect all fees and assessments, and receive all donations in money which may be made to it, shall pay all accounts against the society when the same shall be approved by a vote of the council, shall keep a correct account of all receipts and expenditures, in books belonging to the society, and shall at each annual meeting, and at other times when required by the council, make a detailed report of the same.

SEC. 6. The librarian shall have charge of the books belonging to the society, or deposited for its use, and of the publications of the society; he shall observe and enforce such regulations as the council shall from time to time make for the use of the books.

Sec. 7. The custodian shall be a person of acknowledged scientific attainments; he shall have general charge of the building and its contents, shall have free access to all the collections at all times, and shall act in concert with the curators, to whom he shall bear the relation of adviser and assistant; in case of the absence or neglect of curators, he shall act in their stead, and perform their duties; he shall prepare and read at the annual meeting a report of the state of the museum, compiled from the special report made to him by the curators; he shall keep a book to be called the donation book, in which shall be recorded, under their respective departments, all donations to the museum, with the date and name of donor; and he shall perform such other duties as may be prescribed by the council, and mutually assented to.

Sec. 8. The curators shall be intrusted with the care of the museum. They shall, as soon as possible, after a donation is made, or specimens received, deposit them in their respective cabinets; each curator shall have his particular department allotted to him at the time of his election, shall arrange the specimens in that department according to some system approved by the custodian, and, so far as practicable, label them with the names they bear in such system; he shall, also, as far as is practicable, keep a correct catalogue of articles in his care, and shall be authorized to select duplicate specimens from the cabinet, and, with the assent of the custodian, effect exchange therewith; each curator shall make a written report to the custodian a month previous to the annual meeting, concerning the collection under his charge, the additions made during the year, and the important deficiencies which exist.

Sec. 9. The council shall control all expenditures of money, make rules for the use of the library and museum, and special rules for the direction of the librarian and custodian, and shall elect annually a committee of five members, to be called the publishing committee; the council shall have full power to act for the interests of the society in any way not inconsistent with the constitution and by-laws.

Sec. 10. The council shall annually appoint three trustees, one of whom shall be treasurer *ex-officio*, to whose charge shall be intrusted all the funded property of the society, with power to sell and re-invest according to their judgment.

ARTICLE III.—OF ASSESSMENTS.

Section 1. Every resident member shall be subject to an annual assessment of five dollars, payable on the first Tuesday of April in each year, but no assessment shall be required of any member during the six months succeeding his election.

SEC. 2. The president and treasurer shall be empowered to exempt (*sub silentio*) a member from assessment, when, from peculiar circumstances, they may deem it for the interest of the society so to do.

ARTICLE IV.—OF THE LIBRARY.

SECTION 1. Members and patrons of the society only shall have access to or take books from the library, but the council may, by special vote, extend the use of books to others than members, specifying the conditions under which they may be taken.

SEC. 2. The rules and regulations of the council, for the use of the library, shall be printed and exposed in the library rooms, and a digest of them affixed to the volumes themselves.

ARTICLE V.—OF THE MUSEUM.

SECTION 1. Members of all classes, and the public generally, shall have access to the museum, at such times as the council shall determine.

SEC. 2. No specimens shall be removed from the museum, without the leave of the custodian and the curator of the department to which they belong, who shall take a receipt for the same, and be responsible for their restoration in good order.

ARTICLE VI.—OF COMMITTEES.

SECTION. 1. The committee on publications shall, from time to time, cause to be published, and superintend the publication of such papers read to the society, and such portions of the records of the proceedings, as may seem to them calculated to promote the interests of science, so far as the funds appropriated by the council shall permit, it being understood that the committee shall not be held responsible for any opinion expressed in said publications. The said committee shall also have authority to effect exchanges for other scientific publications.

SEC. 2. The council shall, previous to every annual meeting, appoint a committee whose duty it shall be to audit the accounts of receipts and expenditures of the corporation.

ARTICLE VII.—OF LECTURES.

SECTION 1. Public lectures, when adjudged expedient by the council, may be given under the auspices of the society.

ARTICLE VIII.—OF MEETINGS.

SECTION 1. A meeting shall be held on the first Tuesday in April, annually, for the choice of officers and other general purposes; at this meeting an annual report, embodying the several reports of the curators and librarian shall be read by the custodian, and a report on the state of the funds by the treasurer, who shall also present an estimate of the necessary expenses of the ensuing year.

SEC. 2. Regular meetings of the society shall be held on the first Tuesday evening of every month, unless when suspended by a vote of the society.

SEC. 3. Nine members shall form a quorum for business.

SEC. 4. The order of proceeding at meetings shall be as follows:

1. Record of the preceding meeting read.
2. Candidates for membership proposed.
3. Balloting for members.
4. Written communications read.
5. Verbal communications made.
6. Business called up by special resolution or otherwise.
7. Donations announced.
8. Adjournment.

ARTICLE IX.—CHANGE OF BY-LAWS.

SECTION 1. The by-laws of the society may be altered or amended by a majority vote of the members present at any meeting, provided that the members of the society shall have been duly notified one month previous of an intended change.

OFFICERS OF THE SOCIETY.

JOHN A. WARDER, President.
DR. W. H. MUSSEY and S. A. MILLER, Vice-Presidents.
L. S. COTTON, Corresponding Secretary.
JOHN M. EDWARDS, Recording Secretary.
H. WOOD, Treasurer.
H. H. HILL, Librarian.
R. B. MOORE, Custodian.
R. M. BYRNES, Curator of Mineralogy.
S. A. MILLER, " " Paleontology.
DR. C. A. MILLER, " " Conchology.
V. T. CHAMBERS, " " Entomology.
JOHN HUSSEY, " " Botany.
CHAS. DURY, " " Taxidermy.
D. S. YOUNG, " " Ichthyology.
DR. W. H. MUSSEY, " " Comparative Anatomy.

LIST OF MEMBERS.

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ROB'T BROWN, JR.
R. M. BYRNES,

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Lucius Curtis,
V. T. Chambers,
Julius Dexter,
Charles Dury,
C. B. Dyer,
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——— Jameson, M. D.
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EDITOR AND PROPRIETOR,

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THE CINCINNATI QUARTERLY

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The Position of the Cincinnati Group in the Geological Column of Fossiliferous Rocks of North America. (BY S. A. MILLER.)

In the early days of the science of geology, the known strata of rocks were divided into systems or formations, each of which was supposed to represent a great period of time, during which no great changes occurred in the condition of the earth, or the animal life that inhabited it. The commencement of each system or formation was supposed to mark a new era of creations, and its close to represent a great cataclysm that destroyed all animal life, and effected great and wonderful changes on the surface of the earth.

Later, however, these systems and formations were found to be of much greater depth than at first supposed, and as the science of geology became better known, they were subdivided into groups, each of which was found to be as distinct and marked in its character as the separate systems and formations were.

And, finally, it was found that the systems and formations were more imaginary than real. That they did not mark periods of time during which there was great repose on the surface of the earth, nor were they ushered in with special creations of organic life, nor closed with violent cataclysms that destroyed every living thing. On the contrary, as the examinations and discoveries began to perfect the geological column, and paleontology became a science, it was ascertained that the special evidences of creations, and cataclysms were missing, and that the never ceasing change which now takes place is the only criterion by which to judge of the changes in the past.

The geological column is therefore to be regarded as one continuous whole, commencing at the base of the metamorphic rocks, and continuing without interruption, and without any break in animal life up through the sedimentary deposits of the present time. The division into systems or formations is retained for convenience to embrace a collection of consecutive groups having some character in common, but not to be understood as necessarily embracing every group having such common characteristic, nor as denying that any group in one system or formation may not have the same lithological appearance, or possess some of the same fossils that a group in another system or formation may have or possess. The division into groups is likewise one of convenience, though it is much more expressive, and less liable to be misunderstood in its actual significance than the older division into systems or formations. By a group we understand, a series of rocks either having the same general lithological appearance, or, though quite different in appearance, having the same fossil contents in general, or sometimes merely signifying the exposure of the strata at a particular locality.

In general it is only through a knowledge of paleontology that strata or groups of rocks at distant places can be compared, and their order of superposition determined. Such knowledge is the key which unlocks and opens to view many miles in thickness of the surface of the earth, and carries us back on a train of thought and observation through many millions of years in time, and through the history of animal development from the highest vertebrate animals of to-day to the foraminifera of the Laurentian Group.

The strata of rocks constituting the Cincinnati Group, though situated at a station on this road far below the fossil remains of the vertebrate kingdom, are yet in the upper half of the geological column of fossiliferous rocks not only of North America, but of their equivalent in Europe and throughout the world.

The immense exposures of the Laurentian, Huronian and Quebec rocks, in separate sections in Canada, the Potsdam in Tennessee, the Catskill in Pennsylvania, and the Coal Measures in Nova Scotia, have afforded the opportunities for measuring the groups having the greatest thickness without appealing to the fossil contents for any assistance; nevertheless the determination of their order of superposition with regard to each other has somewhat depended upon their fossil contents, and that of adjacent underlying or superimposed strata, while many of the smaller groups have been placed in the geological column, after a careful examination and thorough knowledge of their fossil contents, which alone has enabled us to determine their relative position.

Prof. Meek, in the introductory remarks to his report on the paleontology of Eastern Nebraska, says:

"There are probably few well informed geologists who will, at the present time, maintain that the occurrence of a very similar, or even the same group of fossils, at widely separated localities, necessarily proves the rocks in which they are found to be of exactly contemporaneous origin. The most that is now generally maintained in this regard is, that such identity or correspondence of types, at very distantly separated parts of the world, indicates that the strata in which they are embedded were formed during the prevalence of identical or similar physical conditions at some time during the same great geological epoch, and that they hold the same, or nearly the same, *relative* position in the geological column of their respective districts. For instance, although a stratum in the Rocky Mountains, containing the remains of very nearly the same fauna as some particular subdivision of the Devonian system of Europe, might, for aught we know, be hundreds of years older or newer than that particular division, we would have little or no room for doubting that it belonged to the great Devonian series, or possibly even to some definite known horizon in that series. We could, moreover, very positively assert, in such a case, that it would be, according to all past experience, useless to seek there at any lower geological horizon for workable beds of coal, or to expect to find Silurian rocks, or any of their peculiar products, above, supposing there had been no overturning of the strata at the particular localities.

"Hence, although paleontology does not enable us to ascertain the exact *actual* ages of rocks, when applied with due caution and skill in connection with a careful observance of their stratigraphical arrangement, and lithological and other physical characters, it does afford the means of fixing their *relative* ages, as well as of identifying the same beds at different localities, within given fields of observation, with very considerable precision. It is, therefore, not merely one of the more important aids to the geologist in his investigations, but in the present state of geological science, it is the only sure guide in classifying and determining the order of succession of rocks, where this can not be done by their actual continuity or obvious superposition."

The Laurentian series of metamorphic rocks forms the base of the sedimentary strata, and has an estimated thickness of 32,750 feet. (Geo. of Can., 1863, p. 45.) It takes its name from the Laurentian Mountains of Canada. *Eozoon Canadense* and other fossil foraminifera have been found at the base of the Grenville band of limestone, which is placed about the middle of this great series. The estimated depth of the Laurentian series to the lowest place at which the *Eozoon Canadense* has been found, is 16,500 feet. Sir W. E. Logan (Geo. of Can. 1866, p. 19) describes the Grenville band in which the fossil is found as follows:

"The general character of the rock connected with the fossil produces the impression that it is a great foraminiferal reef, in which the pyroxene masses represent a more ancient portion, which having died, and become much broken up, and worn into cavities and deep recesses, afforded a seat for a new growth of foraminifera, represented by the calcareo serpentinous part. This in its turn became broken up, leaving, however, in some places, uninjured portions of the organic structure. The main difference between this foraminiferal reef, and more recent coral reefs, seems to be, that while with the latter are usually associated many shells and other organic remains, in the more ancient one the only remains yet found are those of the animal which built the reef."

The next series of rocks overlying the Laurentian are called the Huronian, which, on the north shore of Lake Huron and to the eastward, consists of quartzites, chloritic slates, bands of limestone chert, jasper and slate conglomerates, not less than 18,000 feet in thickness.

On Lake Superior, Sault Ste. Marie, Mamainse, and other places, they are exposed from 10,000 to 16,208 feet in thickness. An approximate estimate of the thickness of this series on Michipicoten Island, says Mr. MacFarlane, is 18,500 feet. And if we compare the rocks of Michipicoten Island with those of Mamainse, it would appear that the lower rocks of the latter series do not come to the surface at Michipicoten Island, and that the higher rocks of the Michipicoten series have not been developed at Mamainse, or lie beneath the waters of the lake to the southwest of the promontory. It would therefore appear just in estimating the thickness of the upper copper-bearing rocks of the eastern part of Lake Superior (which are Huronian), to add to the Mamainse series the above mentioned 4,000 feet of resinous traps, or porphyrites, which would make the whole thickness at least 20,000 feet. (Geo. of Can., 1863, pp. 55, 67, 86; Geo. of Can., 1866, pp. 132, 141.)

The metamorphic strata, equivalent to the Laurentian and Huronian series of Canada, is described in Safford's Geological Survey of Tennessee, p. 178, as many thousand feet thick in that State. Fossil remains of foraminifera have been found in it. They have also been found in the metamorphic rocks of Europe, several thousand feet below their surface.

Next above the Huronian or metamorphic rocks lies the great Silurian formation, named by Sir R. I. Murchison, in memory of the ancient Silures who inhabited Wales, where he first studied the exposure of the rocks. He subdivided it into the Lower Silurian and Upper Silurian formations, and those names have been adopted in this country almost without exception. The Lower Silurian is divided into groups or subdivisions in ascending order, as follows:

1st. The St. John's Group, consisting of black shales and sandstones, resting conformably upon still older schistose rocks, at St. John's, New Brunswick, 3,000 feet thick. (Geo. of Can., 1866, p. 235.)

2d. The Potsdam sandstone, which takes its name from Potsdam, in Northern New York, where it is well developed, and consists of a fine-grained, even-bedded sandstone, traversed by parallel vertical joints. It is about 2,000 feet thick in Pennsylvania and West Virginia, 1,147 feet at the Straits of Belle Isle, 2,020 feet at Bonne Bay, Newfoundland, and from 500 to 2,500 feet in thickness at other places in Canada. It is divided into three great sub-groups in Tennessee, in ascending order, as follows: 1. Ocoee conglomerate and slates; 2. Chilhowee sandstone; 3. Knox Group. The Ocoee conglomerate and slates takes its name from the Ocoee River, and is 10,000 feet in thickness. The Chilhowee sandstone takes its name from the Chilhowee Mountain, and is 2,000 feet thick. The Knox Group takes its name from Knox county, and is 7,000 feet in thickness; thus making the total thickness of the Potsdam 19,000 feet in Tennessee. (Safford's Geo. of Tenn., p. 158.)

3d. The Calciferous Group, which is exposed in Illinois, Missouri, Tennessee, New York, Pennsylvania, Canada, and other places, usually less than 500 feet in thickness, is 1,315 feet thick in Missouri. (Geo. of Mo., pp. 60, 116), and 1,839 feet in Newfoundland. (Billing's Pal., p. 208.)

4th. The Quebec Group, which is subdivided into the Levis, Lauzon and Sillery. The Levis division comprehends the Philipsburgh rocks, which are 4,860 feet thick, in addition to 1,285 feet of the Orleans section, making the whole division 6,145 feet thick. The Lauzon division reaches nearly 4,000 feet in thickness, and the Sillery 2,000 feet, making the maximum depth of the three divisions of this group 12,145 feet. (Geo. of Can., 1866, pp. 30, 36.) Some of the fossils of this group are found in both the Chazy and Calciferous rocks, and the Canadian geologists for a time supposed it to be the equivalent of these rocks, but later investigations have shown that it has a fauna of its own, and that it offers beds of passage from the Potsdam to the Trenton fauna, in addition to those of the Chazy and Calciferous. (Billing's Pal., p. 64.)

There is in Newfoundland an important series of strata, having a thickness of 2,061 feet, lying below the Levis formation, and above the

Calciferous, which has not been recognized in Canada. It thus appears that the Levis formation not only lies above the Calciferous, but more than 2,000 feet above it. Yet it holds a large number of trilobites of the Potsdam type, and several species which certainly do occur in the Calciferous. (Billing's Pal., p. 376.)

5th. The Chazy limestone, which takes its name from Chazy, Clinton county, New York, has an extensive range over New York, the Island of Anticosti, and Canada, but is seldom found over 300 feet in thickness.

6th. The Black river and Birdseye limestone, which is found in Canada, and the Island of Anticosti, in New York, Missouri, and other places, usually of no very important thickness, but in Pennsylvania its maximum is estimated at 5,500 feet. (Geo. of Penn., vol. i., p. 105.)

7th. The Trenton Group, which takes its name from Trenton, Oneida county, New York, is highly fossiliferous, and is found almost everywhere on the continent where the Lower Silurian rocks are exposed. In New York, Pennsylvania, Missouri, Illinois, and Canada, its greatest thickness does not exceed 1,000 feet, while on the Island of Anticosti it reaches 1,700 feet, and in Tennessee 2,500 feet. (Geo. of Tenn., p. 160.)

8th. The Black slate or Utica shale, which is confined in its range to Pennsylvania, New York, and Canada, and reaches its greatest thickness in Pennsylvania, at 400 feet. (Geo. of Penn., vol. i., p. 105.)

9th. The Cincinnati Group, which is situated at the top of the Lower Silurian, and has a total thickness exposed in Kentucky, Ohio, and Indiana, of about 1,000 feet, is the equivalent of the Hudson River Group of New York, which is exposed from 500 to 800 feet. It is the equivalent of the Matinal Shales of Pennsylvania, which are 1,200 feet thick, and the Cape Girardeau limestone of Missouri, which is 165 feet in thickness. It is 150 feet thick at Green Bay, and other places in Michigan, 250 feet at Chicago, as found by boring an artesian well, and from 150 to 200 feet at other places in Illinois. It is 500 feet thick at Cape Rich, on Georgian Bay, 960 feet on the Island of Anticosti, 800 feet at Collingwood, Canada, where it is interposed as in New York between the Trenton and Medina Groups, while its greatest thickness in Canada is 2,000 feet. (Geo. of Can., 1863, p. 200.)

The maximum thickness of the Lower Silurian, at the places mentioned, is thus seen to be 46,684 feet, and the fossiliferous part of the metamorphic rocks, 36,500 feet. Total, 83,184 feet, or fifteen miles and three fourths, from the top of the Cincinnati Group to the base of the fossiliferous rocks. As we have here estimated the greatest thickness of the Cincinnati Group from Canada at 2,000 feet, the true position will be best understood by estimating the depth below the base of the Cincinnati Group at fifteen miles and a quarter. In other words, if all the formations were fully represented here in their greatest thickness, we would expect to find fossils by digging and boring at Cincinnati all the way down for fifteen and one quarter miles. The fact is, however, that part of the earth has always been dry land, whilst another part has been covered with an ocean. The dry land has always been worn away, as it is at the present time, by the action of rain and atmospheric causes, whilst the ocean bed has gradually filled up, as the Atlantic ocean fills to-day by sedimentary deposition, so slow it may be that one foot of deposit represents more than one thousand years, but nevertheless a true chronicle of the lapse of time. The maximum thickness, therefore, of each of the several groups of strata belonging to the greater geological formations, is the measure of the lapse of the time that transpired during its deposition on the ocean bed, and when placed together, in their order of time and deposition, these groups constitute the true geological column. And where any group of strata is missing, the column of animal life is likewise connected in some manner by its fossil contents elsewhere. The lapse of time is estimated by the thickness of the rocks, and the internal evidences of the manner of their formation. And it is a general rule that where fossils are abundant, and varieties numerous, the deposition of rocks was extremely slow, and where the fossils are well preserved, scarce and uniform in their appearance, the deposition was much more rapid. The larger part of the rocks, too, have the appearance of having been deposited from mineral matter held by the water in chemical solution, so extremely slow, that a *Bryozoan* could grow on a shell for many years, within one sixteenth of an inch of the mud, without ever being troubled with its near approach, or finding out in old age that he could reach with his cilia any nearer the bottom than he could in his youth. It has been most clearly proven by paleontological testimony, that there was no break in the continuity of animal life during this immense period of time, and especially it is clearly demonstrated that there was no break during the deposition of the nine miles in thickness of the rocks of the Lower Silurian era, and yet the *Trilobites* and the *Orthoceratites* were the highest organized and largest developed animals that had an existence. Each succeeding group of rocks contains additional varieties and species, and represents a more numerous and higher development of animal life, ranging from the foraminifera to the cephalopoda and crustacea of the ocean, but never containing even a fragment of a land invertebrate.

This great thickness of the Lower Silurian rocks of North America is fully equaled by the Lower Silurian of Europe, and especially of England and Scotland, where it is estimated at 50,000 feet (Murchison's Siluria, p. 174). And the development of animal life, as shown by the fossil contents of the strata of Europe, was precisely the equivalent of that in America.

Overlying the Cincinnati Group, we have the Upper Silurian rocks, which are subdivided in ascending order, into: 1st, Oneida conglomerate; 2d, Medina sandstone; 3d, Clinton Group; 4th, Niagara Group; 5th, Onandaga Salt Group; and 6th, Lower Helderberg.

The Oneida conglomerate is 400 feet thick in Pennsylvania, and 500 feet in New York. (Rep. 1st Dist., N. Y., p. 356.)

The Medina sandstone is 350 feet thick in New York, between the mouth of the Niagara and Lewiston; 618 feet at Barton, Canada, and 1,150 feet in Pennsylvania. (Geo. of Penn., vol. i., p. 105.)

Immediately overlying the Cincinnati Group, in Ohio, and other western localities, we find either the Clinton or Niagara Group, and a somewhat general change of species in animal life; a few, however, pass from the Cincinnati Group even to the Niagara. In New York and other eastern localities, however, where the Oneida conglomerate and Medina sandstone are interposed between the Cincinnati and Clinton Groups, the fossils graduate from one group into the next higher, without greater changes than are to be found within each separate group, and in such manner as to show that there was no break in animal life. The same state of facts exist in England, Scotland, Wales, and Bohemia, where the fossils pass from the Lower Silurian to the Upper Silurian, in such manner as to demonstrate that there was no great disturbance of the animals that lived in the sea, if indeed there is any evidence to show that a greater change took place, either on land or sea, than that which is taking place to-day, or takes place during the deposition of any group of strata.

Prof. Billings says that on the Island of Anticosti there is "a deposit of argilaceous limestone, 2,300 feet in thickness, regularly stratified, in nearly horizontal and perfectly comformable beds. All the facts tend to show that these strata were accumulated in a quiet sea, in uninterrupted succession, during that period in which the upper part of the Hudson River Group, the Oneida conglomerate, the Medina sandstone, and the Clinton Group, were in the course of being deposited in that part of the Paleozoic ocean now constituting the State of New York and some of the countries adjacent. If this view be correct, then the Anticosti rocks become highly interesting, because they give us in great perfection a fauna hitherto unknown to the paleontology of North America. When the great thickness of the rocks between the Hudson River and Clinton Groups is considered, it becomes evident that a vast period of time must have passed away during their deposition; and, yet, as the Oneida conglomerate is unfossiliferous, and the Medina sandstone has yielded but a few inconspicuous species, we have been almost wholly without the means of ascertaining the natural history of the American seas of that epoch. The fossils of the middle portion of the rocks of Anticosti fill this blank exactly, and furnish us with the materials for connecting the Hudson River Group with the Clinton by beds of passage containing some of the characteristic fossils of both formations, associated with many new species which do not occur in either. (Geo. of Can., 1856, p. 249.)

The Medina sandstone in Western New York, in some localities, is highly fossiliferous, and in some places the fossiliferous part reaches a maximum, says Prof. Hall, of more than one hundred feet.

The Clinton Group is only estimated, in Ohio and other western localities, at 50 feet or less in thickness. In New York and Canada from 50 to 400 feet, and on the Island of Anticosti at 610 feet; but in Pennsylvania it reaches the great thickness of 1,620 feet. (Geo. of Penn., vol. i., p. 106).

Prof. Hall says of this group: "In the western portion of the State (N. Y.) the limit between the Medina sandstone and Clinton Group is well defined, and the materials very distinct; but, in the central part of the State, we find the same conditions which operated during the deposition of the Medina sandstone to have been continued into the Clinton Group. The latter commences by a shaly deposit, which is soon succeeded by alternations of sandstone, in character precisely like the Medina sandstone. The general character of the marine vegetation of the two periods is similar; and a peculiar type of plants commences its existence in the Medina sandstone, and terminates in the Clinton Group. When we examine the Clinton Group in the central part of the State, its analogies are chiefly with the Medina sandstone; and it is there a powerful and important formation, presenting, however, great variation in its successive beds, and characters in every respect truly protean. In its western extension, the Clinton Group assimilates in character to the Niagara Group, and in the western district has nearly lost the character which it presents in Oneida county. At the same time that the group assumes a more calcareous character in its western extension, it loses the fossils which were typical of it, and becomes charged with fossils peculiar to calcareous strata. Thus, while we find its lower beds, from Wayne county westward to the Niagara river, characterized by peculiar fossils, we find the upper beds containing many species which pass upward into the Niagara Group. Indeed, there is no line which can be designated between these two groups which shall mark the limits of the organic products. It is true, nevertheless, that by far the greater part of the fossils of the two groups are distinct; and the small number in the lower Group, of those which we regard as proper to the Niagara Group, are for the most part inconspicuous, and not so well developed as they are in the Niagara."

Again, he says:

"In tracing the Clinton Group westerly, we find its affinities more with the rocks below, or that the material and fossils recognized on the one side as the Clinton formation are not strongly separated from the upper beds of the Hudson River Group; and studied in these localities alone, they might be regarded as constituting part of the same. On the other hand, the Niagara becomes defined as a calcareous group, and the line between it and the strata below is strongly drawn. The base of this limestone would everywhere be recognized as the base of the Upper Silurian rocks, while the strata below are marked by fossils which belong to the Lower Silurian fauna."

The Niagara Group consists of the Niagara shales and limestones, and the Guelph and Leclaire Groups. At Lockport and Niagara Falls it consists of 80 feet of shales and 164 feet of limestones. The Guelph Group takes its name from the town of Guelph in Canada, where it is about 160 feet in thickness. It is like the Niagara limestones on which it rests, a dolomite, and on Manitoulin Island, where the limestones are 405 feet thick, it is 100 feet in thickness. The greatest thickness in Ohio, Indiana, or Illinois, will not, probably, exceed 400 feet, but in Tennessee it is found 1,700 feet thick, and is subdivided as follows: 1st, Clinch Mountain sandstone, consisting of shales and sandstones, 700 feet; 2d, the White Oak Mountain sandstone, 500 feet; 3d, the Dyestone Group of shales and sandstones, which takes its name from an iron ore which is sometimes used as a dyestone, 300 feet; and 4th, the Meniscus limestone, which takes its name from a lens or menicus-shaped fossil sponge, named by Rœmer *Astreaspongia meniscus*, 200 feet.

Prof. Hall says:

"The rocks of this group, where best developed in Western New York, consist of a mass of shale, succeeded by one of limestone, the passage from the former to the latter taking place by the gradual increase of calcareous matter. The upper or terminating limestone of the Clinton Group is succeeded by a soft argillo-calcareous shale, which maintains its character unchanged for a thickness of 80 to 100 feet. Throughout the greater part of this it abounds in fossils, nearly all of which are quite distinct from those in the beds of the Clinton Group.

"In the western part of New York, the lithological characters of the Clinton and Niagara Groups are so similar that they could well be united. The fossils also of the two groups, though generally distinct, are nevertheless generically similar, and several species pass from the lower to the higher group. The upper limestone of the Clinton Group, which forms a strong line of demarkation between the two, contains in its western extension several fossils usually regarded as peculiar to the Niagara Group. Among these may be noticed the *Caryocrinus ornatus*, and the *Hypanthocrinus decorus*. It can not be denied, therefore, that there is a gradual approximation in the two groups, both in lithological and paleontological characters, as we trace them westward within the limits of the State of New York. Still farther west, the assimilation becomes more perfect, and there appears to be no line of separation between the two groups. At the same time the fossils appear to be commingled." (Pal. of N. Y., vol. iii., p. 106.)

The Onandaga Salt Group takes its name from Onandaga county, New York, where the salt springs have been extensively wrought. It is sometimes called the Onandaga limestone, or the Gypsiferous series.

Its outcrop in New York is traced from Montgomery county, where the formation is represented by a thin band, westward, till it attains, in Wayne county, a thickness of 700, and even 1,000 feet, and, finally, reduced once more to less than 300 feet, crosses the Niagara river into Canada, whence it is traced northwestward, forming a band between the outcrops of the Corniferous and Guelph formations to Lake Huron, and thence to Mackinac. (Geo. of Can., 1866, p. 263.)

This formation, in its lower part, is made up chiefly of marls and thin shaly limestones, which include the gypsum and salt. Its upper portion consists of magnesian limestones, often yielding hydraulic or water lime, and is, hence, sometimes distinguished as the water lime group, though really forming a part of the Onandaga formation. It attains a thickness in Canada of 800 to 1,000 feet. (Geo. of Can., 1866, p. 237.) But in Pennsylvania, where it is called the Surgent red marl, it is only 350 feet thick.

The Lower Helderberg Group is so termed from its complete development along the base of the Helderberg Mountains. In some parts of the Helderberg Mountains, and in other parts of New York, it rests directly upon the water lime beds, which is the uppermost member of the Onandaga salt group.

It was separated in New York by Vanuxem into five subdivisions in ascending order, as follows; 1st, Water lime group or Tentaculite limestone, 200 feet thick, some layers of which yield hydraulic cement, from which the subdivision took its name. This group crosses into Canada, where it is found 45 feet thick; 2d, Pentamerus limestone, 30 feet thick, at Cherry Valley, and which took its name from the abundance of *Pentamerus galeatus* found within it; 3d, Delthyris shaly limestone, 70 feet thick, in Albany county, which took its name from the abundance of *Spirifera macropleura*, and *S. pachoptera*, formerly called *Delthyris*; 4th, Encrinal limestone, 25 feet thick, which took its name from the quantity of broken encrinites it contains. It has also been called the scutella limestone, from a shield-like pelvis of a crinoid found in it; 5th, Upper Pentamerus limestone, 75 feet thick, and which took its name from the *Pentamerus pseudogaleatus*, with which it is characterized.

While this group is only from 100 to 200 feet thick in Ohio and the western States, and only from 400 to 500 feet thick in New York, it is 1,720 feet thick in Pennsylvania, and at Gaspe, Canada, where it lies immediately beneath the Oriskany sandstone—it is 2,000 feet in thickness. (Geo. of Can., 1866, p. 260.)

From these estimates we find that the rocks belonging to the so-called Silurian system, overlying the Cincinnati Group, are 7,970 feet in thickness, or about one mile and a half. They contain the fossil remains of no vertebrate animal so far as yet known. They show, however, the uninterrupted course of oceanic life from one group to another, as the same is shown by their equivalents in Europe and other parts of the world.

Prof. Hall says:

"The fossils of the Lower Helderberg are analagous to the fossils of the Niagara Group, which is everywhere evident from comparison, and the graduation is so slow, from one formation to the other, that they are grouped together in one system, the Upper Silurian."

Next above the Upper Silurian rocks come the Devonian, from Devonshire, England. They are subdivided in ascending order, into: 1st, Oriskany sandstone; 2d, Upper Helderberg; 3d, Hamilton Group; 4th, Portage Group; 5th, Chemung Group; and 6th, the Catskill Group.

The Oriskany sandstone takes its name from Oriskany, New York. It is found only 10 feet thick in Ohio, but in Illinois, Pennsylvania, Maryland, New York, and Canada, its thickness varies from 100 to 300 feet.

Prof. Hall says:

"The lines of demarkation between subordinate groups, and the line of separation between systems, are equally strong, and that the whole series may be regarded as a succession of minor groups; that the strong lines of division are almost always due to the absence of some formation, which, if present, would show a gradation to the next; and these subdivisions into systems have been made dependent on the imperfection rather than the perfection of the sequence. Thus the strong line of demarkation between the Silurian and Devonian which exists where the Lower Helderberg Group is absent, is softened to a gentle gradation through the intervention of these strata and the Oriskany sandstone. Where these are present in all their members, the line of separation becomes less sharply defined, and we have some evidence that there may exist other intermediate members, or a more full development of those now known between the two formations." (Pal. of N. Y., vol. iii., p. 35.)

In Southern Illinois, the Oriskany sandstone of the Devonian system is underlaid by a group of silicious limestones, that in their upper beds contain well marked Devonian fossils, and below those that seem to be characteristic, Upper Silurian forms; thus forming beds of passage from the Upper Silurian to the Devonian systems. This group seems to hold about the same relation to these two systems that the Anticosti Group of Canada holds between the Upper and Lower Silurian of that country. This group is called the "Clear Creek limestone," and is limited in its outcrop to the counties of Jackson, Union, and Alexander, first making its appearance in the bluffs of Mississippi, at the lower end of the ridge known as the "Devil's backbone," in Jackson county, and continuing along the river bluffs to Clear creek, in Union county, where they are fully developed, and where they probably attain their maximum thickness of from 250 to 350 feet. (Geo. of Ill., vol i., p. 125.) Subsequent investigations, and a more complete collection of the fossils which belonged to the upper and lower divisions of the mass, led to the conclusion that the upper division represented, at least in part, the Oriskany period, and the lower, the Delthyris shaly beds of the Lower Helderberg series. And in accordance with this view, without any well marked line of separation on lithological grounds, but supported by an examination of the same beds in Perry county, Missouri, the upper 200 feet, at the maximum thickness, is placed in the lower division of the Oriskany period, and the lower 200 feet, at the maximum thickness, is placed in the Lower Helderberg period. (Geo. of Ill., vol. ii., p. 8; vol. iii., p. 24.)

The Upper Helderberg group, in its fullest development, consists of four members, the Cauda galli grit, the Schoharie grit, the Onandaga and Corniferous limestones. The first, when characteristic, is a dark, gritty slate, which, even in its unaltered condition, has a cleavage vertical to the line of deposition, and is generally destitute of fossils; but with surfaces covered with curved, fucoid-like marking, which have given it its name. This rock constitutes beds of passage from the Oriskany sandstone, and graduates above into the Schoharie grit, which is an arenaceous limestone, weathering to a brownish color, and succeeded by the gray, subcrystalline, coralline formation, which is known in New York as the Onandaga limestone, while the Corniferous limestone consists of the higher, dark-colored chert beds of the group. (Hall's Pal., vol. iii., p. 43.)

The Cauda galli grit takes its name from a fucoid, having some resemblance in form to the tail of a chicken cock. It is 70 feet thick in New York, where the Schoharie grit is only four feet in thickness, but in Pennsylvania and in New Jersey, northeast of the Delaware water gap, these two groups, called the Post Meridian grits, are 300 feet in thickness. (Geo. of Penn., vol. i., p. 107.)

The Onandaga limestone is only from 20 to 50 feet thick in New York, and, though traced over a great extent of country, it rarely exceeds that thickness. In Missouri it varies from 10 inches to 75 feet in thickness. (Geo. of Mo., p. 108.)

The Corniferous limestone, takes its name from the chert found in it that breaks with a horny fracture. It varies from 100 to 200 feet in thickness in Ohio, Illinois, Pennsylvania, and New York. It is from 300 to 400 feet thick in Michigan, and 850 feet thick in Tilsonburg, Canada. (Geo. of Can., 1866, p. 268.)

The maximum of these subdivisions of the Upper Helderburg Group is therefore 1,225 feet. Each subdivision in New York is characterized by distinctive fossils, but in Canada several of the most characteristic species belonging to the Oriskany sandstone ascend through each of the overlying subdivisions into the Corniferous Group.

The Hamilton Group, in its fullest development, consists of the Marcellus shale, Ludlowville shale, Encrinal limestone, Moscow shale, Tully limestone, and Genessee slate.

Prof. Hall says:

"The Hamilton Group consists, in Eastern New York, at base of the black Marcellus shale, including some bands, of goniatite limestone. Next succeeds a hard, compact, calcareo arenaceous shale, which, under atmospheric influences, crumbles into angular fragments. This is followed by more arenaceous bands, and by bands of soft, slaty shale, with arenaceous shale or argillaceous sandstone, and with some thin bands of limestone, which are almost entirely composed of organic remains. Toward the western part of New York, the coarser materials gradually diminish, and we find an increasing proportion of soft shales, with a more general diffusion of the calcareous matter, and the mass is terminated by a limestone. Finally, from the Genessee river to the western limits of the State, the entire group, above the Marcellus shale, which is persistent, consists of dark, soft shales and bands of limestone. Thus the lithological characters are at the east, an olive shale and sandstone; at the west, a grayish-blue, calcareous shale, with bands of limestone. (Pal., vol. iii., p. 46.)

The Hamilton Group is more than 1,000 feet thick in Eastern New York, and 1,150 feet in Eastern Pennsylvania. (Geo. of Penn., vol. i., p. 107.) It thins out westerly to 50 feet in Missouri, and 100 feet in Tennessee, but maintains a thickness in Canada of from 300 to 600 feet.

The Portage Group is 1,400 feet thick in Eastern New York, and 1,700 feet thick at Huntingdon, Pennsylvania. (Geo. of Penn., vol. i., p. 108.) It thins out westerly and northerly. The black slate, or Huron shale, in Northern Ohio, is a part of this group, and has an average thickness of from 300 to 400 feet.

The Chemung Group is about 2,000 feet thick in Eastern New York, but at Huntingdon, Pennsylvania, it is 3,200 feet in thickness. (Geo. of Penn., vol. i., p. 108.) It thins out westerly to 400 feet in Northern Ohio, and 200 feet in Missouri. While the Hamilton, Portage, and Chemung Groups in New York are, combined, only about 4,000 feet in thickness, and in Pennsylvania do not much exceed 6,000 feet, at Gaspe, Canada, they are 7,036 feet, though this estimate may include the Catskill Group.

The passage from the Silurian formation to the Devonian, at Gaspe, Canada, where the rocks are exposed 9,000 feet in thickness, is not evidenced by any change in the lithological character of the rocks, and is hardly determinable from examination of the fossils. The lower 2,000 feet is classed with the Helderberg Group in the Silurian, but it may include the Oriskany sandstone of the Devonian series. The upper 7,036 feet are supposed to represent all the other groups in the Devonian formation of New York, but the divisions are not clearly marked as in New York, nor readily separable from an examination of either the fossils or the rocks. (Geo. of Can., 1863, p. 396; do., 1866, p. 260; Hall's Pal., vol. iii., p. 45.)

The shales and sandstones of the Catskill Group form in their greatest expansion, at the Catskill Mountains, a mass of at least 3,000 feet in thickness. The group is composed of red and greenish or olive shales and shaly sandstones, with some gray and mottled sandstones and conglomerates. (Pal. of N. Y., vol. iii., p. 51.)

In Pennsylvania this group is divided into: 1st, The Ponent red sandstone, which is 5,000 feet thick in its southeastern outcrops; 2d, Vespertine conglomerate and sandstone, which is 2,660 feet in thickness, near the Susquehanna. Making the total thickness of 7,660 feet. (Geo. of Penn., vol. i., p. 108.)

The rocks of Devonian age are therefore 15,235 feet, or nearly three miles in thickness, and are connected together by their interlocking fossil contents, and united with those of Silurian age, precisely as the Lower Silurian Groups are related to each other.

The Devonian rocks are followed by the Carboniferous, which are divided into: 1st, Lower Carboniferous; 2d, Carboniferous conglomerate; 3d, Coal measures; and 4th, Permian.

The Lower Carboniferous Group, in Nova Scotia, consists of reddish and gray sandstones and shales, conglomerates and thick beds of limestone, with marine shells and gypsum, having a thickness of 7,636 feet. (Acadian Geo., pp. 118, 127, 178.) In Pennsylvania it is 3,000 feet; in Ohio, 640 feet; in Illinois, 1,500 feet; in Missouri, 1,145 feet, and in Tennessee, 1,250 feet in thickness. On the Island of Bonaventure, it is about 2,000 feet in thickness, or with the Carboniferous conglomerate, 2,766 feet, and contains the *Eatonia peculiaris*, which is found in the Devonian rocks of New York.

The Carboniferous conglomerate is 1,400 feet in thickness in Pennsylvania (Pal. of N. Y., vol. iii., p. 59), and entirely thins out before reaching the Mississippi river. It is only from 100 to 200 feet thick in Ohio.

Prof. Hall says: "it was evidently formed from the fragments of older formations, drifted, water-worn, rounded and deposited with the larger pieces at the base, and the whole cemented together with smaller pebbles and sand. The depth of the formation in Pennsylvania and its thinning out to the north and west shows the current to have been from southeast to northwest, and probably indicates the close proximity of the source in a southeasterly direction. In Michigan the thinning out is toward the south, or in a contrary direction. In Illinois the formation thins out from the west toward the east. The character of this formation, its manner of deposition, the currents which must have existed to distribute it, all indicate that this continent was an archipelago at the era of the Carboniferous conglomerate."

There is a thickness of 10,000 feet from the summit of the Hamilton Group to the base of the coal measures in Eastern Pennsylvania, and 12,000 feet in the Anthracite region, while in the northwestern part of that State, it attains a thickness of only 2,000 feet. (Geo. of Can., 1866, p. 239.)

The coal measures are 14,570 feet thick in Nova Scotia (Acadian Geo., p. 177), 8,000 feet in Pennsylvania, 2,000 feet in Ohio, 2,500 feet in Tennessee, 1,200 feet in Illinois, 640 feet in Missouri, 2,000 feet in Kansas, and a greater thickness westwardly, in Nebraska.

The maximum thickness, therefore, of the carboniferous rocks is 23,606 feet, or nearly four and one half miles.

The Triassic and Jurassic formations have been variously estimated as to thickness in several western territories. There can be no doubt, however, that, at the maximum, 3,000 feet of these rocks intervene between the carboniferous and cretaceous rocks, as will be seen from the report of Prof. Newberry, geologist to Ives Colorado Expedition, Hayden's Reports on Montana, Wyoming, etc., and the Geological Reports of the Pacific R. R. Survey.

The Cretaceous Group is subdivided in Tennessee in the ascending order, into: 1st, Coffee sand; 2d, Green sand, or shell bed; 3d, Ripley Group. The Coffee sand takes its name from Coffee Bluff, or a supposed resemblance in color, and is 200 feet in thickness. The Green sand takes its name from the green grains found in it, and is 350 fee thick. The Ripley Group is 500 feet in thickness, making the maximum depth in Tennessee 1,050 feet. (Geo. of Tenn., p. 165.)

It is subdivided in Mississippi, Alabama, and Louisiana, in ascending order, into: 1st, Eutaw Group; 2d, Tombigbee sand; 3d, Rotten limestone; 4th, Ripley Group. The Eutaw Group takes its name from Eutaw, Alabama, and is about 400 feet in thickness, and is the equivalent of the Coffee sand of Tennessee. The Tombigbee sand takes its name from the river of that name, and is about 100 feet thick. The Rotten limestone is about 1,200 feet in thickness, the Ripley Group is about 350 feet thick. Making the total thickness in these States 2,050 feet.

The Cretaceous Group is, however, much thicker than this on the great plains west of the Mississippi, where 3,000 or even 4,000 feet will probably not be an overestimate.

The Tertiary Group of Mississippi, Alabama, and Louisiana, is divided in ascending order, into: 1st, Northern Lignitic; 2d, Claiborne Group; 3d, Jackson Group; 4th, Vicksburg Group; 5th, Grand Gulf Group. The maximum thickness of all is about 1,500 feet. The Tertiary, on the Alantic coast, falls far below this maximum, but it exceeds it in Texas and the western territories. The Miocene strata alone, of California, is 2,211 feet in thickness, and Prof. Blake estimated the total thickness of the Tertiary series of strata in that State at not less than 3,000 feet. On the coast range of mountains the Tertiary is supposed to be the thickest of any part of the continent, and to much exceed 3,000 feet.

The Post Tertiary may be estimated at 1,000 feet, including the drift sand and gravel.

The total thickness of the strata which have been deposited since the deposition of the Cincinnati rocks is thus shown to be 57,816 feet, or nearly eleven miles. The total depth of the geological column, as thus represented, is nearly twenty-seven miles. All of which will more readily appear by the following tabular statement:

A Tabular View of the Maximum Thickness of the Fossilliferous Formations, their Divisions, and Groups, as Found in the Carefully Explored Parts of North America, beginning with the Lowest Group, and Ascending through the Series.

1st. Metamorphic:

	Feet.
Laurentian series from the Eozoon Canadense	16,500
Huronian series	20,000

2d. Lower Silurian:

St. Johns Group	3,000
Potsdam	19,000
Calciferous	1,830
Quebec	12,145
Chazy	300
Black river and Birdseye	5,500
Trenton	2,500
Utica Shales	400
Cincinnati Group	2,000

3d. Upper Silurian:

Oneida Conglomerate and Medina sandstone	1,650
Clinton Group	1,625
Niagara Group	1,700
Onandaga Salt Group	1,000
Lower Helderberg	2,000

4th. Devonian:

Oriskany sandstone	300
Upper Helderberg	1,225
Hamilton Group	1,150
Portage Group	1,700
Chemung Group	3 200
Catskill Group	7,660

5th. Carboniferous:

Lower Carboniferous	7,636
Carboniferous conglomerate	1,400
Coal measures	14,570

	Feet.
6th. Triassic and Jurassic	3,000
7th. Cretaceous	4,000
8th. Tertiary	3,000
9th. Post Tertiary	1,000
Total thickness	141,000

This is about twenty-six miles and seven tenths. When the country is more closely surveyed by geologists, a few thousand feet will probably be added to this column.

Monograph of the Crustacea of the Cincinnati Group. (By S. A. Miller.)

Every collector of fossils in the Cincinnati Group, and every student of its paleontology will bear testimony to the great difficulty experienced in finding either the specific or generic descriptions of fossils, both of which are necessary, in order to become reasonably satisfied of the correctness of the names by which they are known, or to become acquainted with the information and labors of our predecessors, or to acquire any definite knowledge of the science. Many of the generic descriptions, and some of the specific, have never appeared in any American publication, and both the home and foreign descriptions are so dispersed among scientific publications, that it requires a library worth several thousand dollars to contain them all. To obviate this difficulty in part, I have compiled the following monograph of the CLASS CRUSTACEA. The characters of the class, the orders, and the families are nearly all copied from British Paleozoic Rocks, by McCoy, as are also some of the generic and specific characters. Other generic and specific descriptions are from the works of Green, Hall, Meek, Jones, etc. I have added only one new species, *Leperditia Byrnesi*, and the description of only a few heretofore unknown parts, but I have pointed out the localities and the range of several species which may have a scientific value, and be of some assistance to collectors. Nor do I regard the tracks (fig. 11), for the first time figured as of slight importance. If they are tracks, and I think there can be no reasonable doubt of it, they are most likely those of a crustacean, and, if so, probably those of an *Asaphus*.

Burmeister was of the opinion that trilobites must have possessed tender, soft feet, which were not used to creep about the bottom of the ocean, but were used only in swimming. That they swam in an inverted position, close beneath the surface of the water, the belly upward, and the back downward, and that they made use of their power of rolling themselves up into a ball as a defense against attacks from above. If they possessed feet adequate for swimming purposes, they must have been sufficient to make these tracks, either when the trilobite was accidently thrown to the bottom of the ocean, or when cast on shore. Indeed, if the trilobites possessed feet either sufficient for the purpose of creeping or swimming, they must have been fully competent when coming into contact with the soft, blue mud, to make these tracks. As it is the opinion of the learned naturalists that trilobites had some kind of feet for the purposes of locomotion, I feel justified in concluding that there is nothing unreasonable in supposing these tracks to be the impressions of the "soft, tender feet," or hard feet, as the case might have been, of an *Asaphus*. Such suppositions are not to be regarded, however, as scientific facts, but simply as sufficient to warrant the placing of the tracks provisionally with that genus. If they swam in an inverted position, it is difficult to understand what purpose some of the spines could have served, and especially such as those which ornament the cephalic shield and back of the *Acidaspis Cincinnatiensis*. I am inclined to think that if they swam, it was with their back upward.

Class Crustacea.

The animals of this class have a hard-jointed integument, composed of a thick, internal, spongy chorium or vascular cutis, a colored, pigmental layer, and a cuticular, secreted, external layer; these three layers are at first all equally flexible and continuous; subsequently, transverse wrinkles appear, which gradually become segments, by the cuticle acquiring calcareous matter, principally carbonate of lime, with a little phosphate of lime and magnesia (and according to some, a little "chitine," as in insects); these solidified bands become segments by separating posteriorly from the lower layer or chorium, which remains flexible, and permits the various motions. Each segment is believed (for they can seldom be all demonstrated) to consist of six pieces, two *tergal pieces* above (separated by a median longitudinal suture), two similar *sternal pieces* below, an *epimerian piece* on the upper half of each side, and an *episternal piece* forming the lower half of each side. In the lower crustacea the segments are very numerous, distinct, and nearly alike, but they gradually coalesce in the higher types, coinciding with the condensation of the nervous centers. No segment ever bears more than one pair of appendages, a fact which is used to demonstrate the true number of the segments which may be anchylosed into the apparently undivided head or thorax of many groups. In the majority of crustacea the first seven joints belong to the head, and bear the organs of sense and parts of the mouth, the next seven to the thorax (according to M. Edwards), bearing the organs of locomotion; this last thoracic joint being always defined by the male sexual openings, and the last seven to the abdomen containing the principal viscera, and having the anus in the last joint. The first ring bears the eyes when they are present, the second and third rings bear the two pair of antennæ, which are absent only in the lowest types, the fourth bears the mandibles, the fifth and sixth the jaws, the appendages of the succeeding rings varying in shape and use according to the group. *Digestion:* the complex mouth is always on the under side of the head, composed of the *labrum* or upper lip, a *labium* or under lip, *jaw-feet, mandibles, maxillæ,* palpi, etc., which it is unnecessary to describe, followed by a short, vertical œsophagus, leading to a large, globular stomach, directly over the mouth (often containing sharp tubercles for triturating the food), from which, as in all the annulata, a straight intestine leads to the anus; there is a well developed liver. *Circulation* by a well developed heart, placed behind the stomach, of mixed blood, which imbibes the chyle from the intestines. *Respiration,* in the higher groups, by gills, which are modifications of the flabelliform appendage of certain legs; in the lowest, apparently by the whole surface of the body, without special organs. *Nervous system,* on the plan of the subkingdom *Articulata. Hearing:* the higher groups hear well, the ear being situated in the base of the second pair of antennæ. *Sight:* a few parasitic groups are blind in their perfect state, but nearly all the rest have perfect eyes, either simple or semi-compound. The simple eyes are small, two or three in number, of a single set of lenses, each eye covered by a round, smooth cornea; the semi-compound eyes are an agglomeration of simple eyes, each with its set of lenses and separate twig of optic nerve, the *group of eyes* covered by *one simple,* smooth, external cornea (true compound eyes, having a separate facet of the outer cornea for each eye beneath). *Reproduction:* sexes always distinct and in different individuals.

"The class *Crustacea* is naturally divisible into the five following orders, commencing with the lowest in organization: 1st, *Cirripedia,* or Barnacles; 2d, *Suctoria,* or the little, parasitic crustacea with tubular mouths; 3d, *Entomostraca;* 4th, *Edriophthalma;* 5th, *Podophthalma,* or most highly organized and having pedunculated eyes (crabs, lobsters, etc.)

Third Order—Entomostraca.

The little crustacea which compose this order are very variable in their characters; they include a vast number of the most minute crustacea known; all those inclosed in a bivalve, shell-like carapace (an extension of one of the cephalic rings) belong to it. They have no gills, but breathe by flat, membranaceous, vascular vesicles, attached to the thoracic extremities, and representing the flabelliform appendage and palpi thereof, modified for the purpose, or by the surface of the body only. The eyes, whether simple or compound, are covered by a smooth cornea. This order, which is of more importance to the geologist than all the rest of the class, is divisible into three tribes, named according to the structure of the feet: 1st, *Phyllopoda*; 2d, *Pœcilopoda*; 3d, *Lophyropoda.*

First Tribe—Phyllopoda.

These have the feet extremely numerous, and, as their name implies, all leaf-shaped. They form extremely numerous, thin, membraneous lobes, subservient to respiration. The tribe is divisible into the following families: 1st, *Lymnadiadæ*; 2d, *Leperditidæ*; 3d, *Apodiadæ*; 4th, *Trilobitadæ*; 5th, *Branchipodiadæ*; 6th, *Daphniadæ* (or *Cladocera*).

Family Lymnadiadæ—(McCoy).

Body entirely inclosed in a vertical, bivalve, calcareo-corneous, oblong carapace, opening along the ventral margin; head adhering to the carapace; twenty to thirty pair of membraneous, respiratory feet; two eyes, either united in one central mass or separate, one soldered to each valve.

The type of this family is the recent genus *Lymnadiadæ*. It is made to include, however, the genera *Beyrichia*, *Cythere*, etc.

Genus *Beyrichia*—(McCoy, 1855).

"Bivalve, rotundato-quadrate or longitudinally oblong, ends unequal; anterior, posterior, and dorsal margins convex, and surrounded by a sharply defined, narrow, tumid border or rim; ventral margin simple, straight or concave; sides tumid, strongly divided into lobes by very deep, nearly vertical furrows, extending from the ventral more or less toward the dorsal margin."

Beyrichia Oculifer—(Hall, 1871).

Carapace small, seldom exceeding 7-100 of an inch in length, by

3-100 to 4-100 in its greatest breadth, in the largest specimens; valves obliquely subreniform, broadest near the anterior end, with a straight hinge line, which is a little shorter than the greatest length of the valve; anterior end projecting beyond the hinge; center moderately convex with a proportionally broad, deep channel, just within the margin, extending all around it, except for a short distance at the posterior extremity, near the dorsal margin. The body of the valve is crossed obliquely by two broad, deep furrows, having their origin on the dorsal margin, the posterior one, situated a little more than one-third of the length of the valve from the posterior extremity, and extending fully two thirds across it; the anterior furrow is situated just behind the anterior third of the length, and its lower portion is more strongly curved forward than the other. Eye tubercle large, pedunculated, very prominent, and spreading at the top, its surface equal to about one third the width of the valve, and its height at the posterior margin equal to the breadth at the top, while the interior margin is but little elevated, giving an obliquely sloping, circular surface, with denticulated border. This surface, under a strong magnifier, is seen to be covered by five eye-like facets, similar to those of the eyes of trilobites of the genus Illænus.

Found abundant in the rocks of Mount Auburn, 390 to 440 feet above low water-mark, and at about the same elevation on all the hills surrounding Cincinnati. Rarely, if ever, seen below 300 feet above low water-mark, but extending from its commencement to near the Upper Silurian. It is a common fossil.

Beyrichia Tumifrons—(Hall, 1871).

Carapace small, subreniform or semi-elliptical, dorsal margin straight, nearly as long as the entire length of the valve; anterior and posterior extremities equal in width, or sometimes having the anterior a little wider; extremities sharply rounded, basal margin very broadly rounded. Surface of valves moderately convex, with a deep, narrow marginal groove on the basal margin, which becomes obsolete on the ends before reaching the dorsal angles, leaving a sharp carinate border. Body of the valve strongly constricted by two deep, oblique sulci, the posterior one originating in the basal groove, and extending obliquely backward two thirds across the valve; the second extends entirely across the valve, at about one third the length from the anterior end, and is strongly curved backward in the middle, so that the anterior portion of the valve forms a rounded area, which is often the most prominent part of the body, though in some specimens the central ridge is equally prominent. Surface minutely granulose; length about 6-100 of an inch, width about 3-100 of an inch. It differs from the *B. oculifer* in being destitute of the prominent eye tubercle.

Found at low water-mark, under the bank of the Ohio, at Fulton; at the excavation for Columbia avenue 160 feet above low water-mark; on the run back of Plainville, and generally at all exposures below 300 feet above low water-mark. It is a common fossil.

Genus *Cythere*—(Muller, 1785).

"*Carapace* often very convex, especially on the ventral portion; sometimes smooth and setigerous, generally pitted, and occasionally reticulated; varying in outline from an acute oval to an irregular oblong; in the first case it often resembles a peach-stone in miniature; in the latter case a central and two posterior tubercles sometimes give a character to the valves; and in each case the anterior, and sometimes the posterior hinge forms an indistinct angle on the dorsal edge; the hinge line of each valve occupies about the middle third of the dorsal margin, and presents a ridge or bar and a furrow, the bar on one valve corresponding to the furrow on the other; the bar is sometimes blended with the edge of the valve, and is occasionally finely crenulated; it is more or less developed at its extremities into cardinal processes or teeth, which with still stronger, but isolated teeth at the ends of the furrow, on the opposite valve, form the anterior and posterior hinges of the carapace; the ventral margin of each valve is more or less incurved near the middle, where its edge is frequently produced (as also occasionally in *Cypris*) into a thin, projecting, laminæ curvilinear plate. The posterior border being always depressed and contracted, and frequently notched at its dorsal angle, forms a low sub-acute marginal rim or "posterior lobe," of varying breadth."

Cythere Cincinnatiensis.—(Meek, 1872.)

Carapace valves varying from transversely suboval to subcircular; moderately and rather evenly convex, the greatest convexity being in the central and anterior regions; without any visible tubercle or nodes; ventral margins rounded or semi-oval, and but slightly unequal or thickened; anterior and posterior margins more or less rounded, the former being more broadly rounded generally than the latter; hinge margin very short, very slightly sinuous just behind the umbones, and rounding into the posterior margin, so as scarcely to produce any visible angularity; umbones, near the anterior, a little tumid, rising very slightly above the hinge, and rounding off regularly into the anterior margin; surface nearly smooth.

It varies much in form and size: one specimen having length, $\frac{21}{100}$ inch; height, $\frac{17}{100}$ inch; convexity, $\frac{11}{100}$ inch; another having length, $\frac{14}{100}$ inch; height, $\frac{8}{100}$ inch; convexity, $\frac{7}{100}$ inch; other specimens being both larger and smaller.

Found on the east side of Avondale pike, back of Cincinnati, with *Orthis bellula*, from 360 to 400 feet above low water mark. As this is the only locality known to me, it is the only one I can point out, but it has been found at other places at about the same elevation. It is a rare fossil.

Family Leperditidæ.

Genus *Leperditia* (Rouault, 1851), as redefined by JONES.

Animal inclosed in a vertical, bivalved carapace. Carapace inequivalved; somewhat resembling a tamarind stone and other leguminaceous seeds. Carapace valves smooth, convex, horny in appearance, nearly oblong, longer than broad, bean-shaped, inequilatoral, posterior half broadest; dorsal border straight; ventral border nearly semi-circular; anterior and posterior borders oblique above, rounded below, the valve margin passing from each end of the hinge line in an oblique direction downward and outward, to about half the breadth of the valve, where it meets the curved ends of the ventral border, and so forms the more or less angular extremities of the valve, the former of which is narrower and sharper than the latter.

Valves united along their upper (dorsal) borders by a simple linear hinge; the two extremities of hinge border form angles with the anterior and posterior borders in each valve.

The right valve larger than the left, being broader, and overlapping completely the ventral border of the opposite valve, and to some extent its anterior and posterior borders. The overlapping ventral border of the right valve forms a thick, blunt keel to the closed carapace.

Each valve is somewhat depressed toward the dorsal border; this border in the left valve is thicker than that of the right, and sometimes slightly overrides it. The ventral margin of the left valve is turned suddenly inward, forming a thin plate, projecting into the cavity of the carapace. The line of junction of the inverted border, or ventral plate, and the outer surface of the valve is angular, and bears a slight sulcus and moulding, against which the overlapping edge of the right valve abuts. The dorsal or the ventral profile of the closed valves is elongate, acute oval; the end view of the closed valves is more or less ovate.

Rather above and in front of the center of each valve, and on its most convex portion, nearly all the species of the genus present a slightly raised, circular or suboval swelling, having a diameter of from one fifth to one quarter of the breadth of the valve's surface. This swelling is distinguishable by a local change of color or of surface condition, and marks the place of a corresponding rounded pit, excavated on the interior surface of the valve so deeply as to render the tissue of the valve at the swelling somewhat diaphanous. The cast of this pit on an inner cast of the valve is strongly marked, having a greater relative height than the external swelling. The swelling has usually a reticulated appearance, resulting from vascular impressions on the test; and from a slight sulcus at the margin of the pit a set of delicate canals, tortuous and inosculating, excavated on the interior of the valve, radiate forward, downward and backward, gradually becoming fainter toward the edges of the valves.

Anterior to the central tubercle, or "lucid spot," and nearer to the dorsal margin, is a smaller, but prominent, tubercle on each valve, with a corresponding internal pit. This little tubercle (the anterior tubercle) is usually seated on or at the edge of a slightly raised area of irregular outline; and behind it a short, shallow, vertical sulcus, commencing at the dorsal margin, is usually apparent.

Leperditia Cylindrica—(Hall, 1871.)

Carapace minute, seldom exceeding $\frac{2}{100}$ths of an inch in length, nearly twice as long as wide; valves very convex and cylindrical, the anterior and posterior ends sub-equal and strongly rounded; cardinal line much shorter than the length of the valve; tubercle obsolete. Surface smooth. Valves do not overlap on the basal border.

Found within eight feet of low water-mark under the Ohio River bank in Fulton, now part of Cincinnati, at the excavation for Columbia avenue, 160 feet above low water-mark, and near the tops of the hills about the city. It is a common fossil, and has an extended range.

Leperditia minutissima—(Hall, 1871.)

Carapace minute, less than $\frac{2}{100}$ths of an inch in length, the width being about two thirds of the length, greatest at the anterior third, giving a broadly ovate outline, with a straight cardinal margin, about two thirds of the length of the valves. Surface of the valves smooth, rising into an obtusely pointed prominence at the anterior third of the length; basal margin of the valves not overlapping so far as ascertained.

Found associated with *Leperditia cylindrica* at various elevations about Cincinnati, but much less abundant.

Leperditia Byrnesi—(S. A. Miller.)

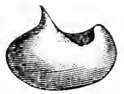

Fig. 10—*Leperditia Byrnesi* Magnified view.

Carapace minute, about $\frac{1}{10}$th of an inch in length, width one third less than length, greatest at the posterior third, with a straight cardinal margin or hinge line nearly the length of the shell. Valves moderately convex. Tubercle at the anterior end, near the dorsal margin, obtuse and apparently directed posteriorly, with a depression or sulcus reaching to the dorsal margin, at the base of the tubercle on the posterior side. Tubercle or spine on the posterior third, near the dorsal margin, rising to an acute point, higher than the anterior tubercle, and projecting to or beyond the dorsal margin. There is a corresponding internal pit for each tubercle and mesial elevation between them. Surface smooth.

The specific name is given in honor of Dr. R. M. Byrnes, of Cincinnati, an ardent student of natural history, active member of the Cinnati Society of Natural History, and indefatigable collector of fossils, shells and minerals.

This species is found within a range of from 7 to 14 feet above low water-mark, under the bank of the Ohio River in the First Ward of Cincinnati. Not observed elsewhere, but this may be owing to the fact that it is so small as to be scarcely visible to the naked eye.

Third Family Trilobitadæ.

Body covered (with a few exceptions) by a longitudinally trilobed crust, the head and abdominal segment anchylosed into distinct cephalic and caudal shields, the thoracic segments alone remaining distinct and movable.

The *cephalic shield* is approximately semi-circular; when most fully developed it presents the following parts: An external, thickened "*limb*" or "*margin*," often prolonged backward at the lateral angles into "*wings;*" the shield is usually divided into two pieces by a suture peculiar to trilobites, termed the "*eye line*" or "*facial suture*," being continuous from one side to the other near the front margin, descending with a slight outward curve to the eye, over which it makes an abrupt outward curve to define a small semi-circular lobe, improperly called the "eye lid;" its direction from the lower end of the eye varies according to the genus, and forms a very valuable character; in some cases the eye lines do not join in front of the glabella, but cut the anterior margin separately, thus dividing the shield into three pieces, and in *Calymene*, to this latter disposition is added a peculiar marginal transverse "rostral suture," dividing the head into four pieces. These sutures exist in no recent *Crustacea*, being now only known in true insects.

By some paleontologists all outside and anterior to the eye line is called the "*cheeks*," and all within or posterior to it is called the "*glabella*;" by a greater number of writers, however, the latter term is used only for the elevated middle portion of the head, and the triangular depressed space on each side form the cheeks, through the middle of which the *eye line* runs; the *glabella* is divided by not more than three lateral sulci into never more than four lobes; at the base of the *glabella* a strong furrow going across is called the "*neck furrow*, behind which is the "*neck segment*" or spira; these sulci indicate the attachment of the buccal muscles. The eyes are reniform, prominent, situated in a gap in the eye line, beneath and external to the eye lid; they have all the "*semi-compound eyes*," the outer thin layer of the cornea being entire and smooth, the inner thick layer facetted and perforated. Burmeister notes that the larger the eye of living crustacea the thinner the cornea; hence, why the large-eyed *Phacops*, having a thin, easily lost, outer cornea, seems to have a facetted eye. I (McCoy) have drawn attention to a deep puncture on each side of the antennary lobe, in the furrow separating the *glabella* from the cheeks near the front margin, which I have called the "*antennary puncta*," and which, I conceive, gave passage to small antennæ, like those of *Branchipus*, of which organs they hold the normal position. Attached to the under side of the anterior edge of the head is an ovate crustaceous piece, varying in shape according to the genus, its anterior part is dilated into two horn-like processes, following the curve of the anterior margin of the shield, the surface of this organ is marked with fine, irregular impressed striæ, like the rest of the under surface of the crust of trilobites; it is believed to be immovable, and corresponds to the enlargement in front of the mouth in some of the recent *Phyllopoda*, and is, as in them named, the "*Hypostoma*." The *Thorax* is formed of a variable number of segments (constant for each genus), forming the movable portion of the crust between the cephalic and caudal shields; it is in general strongly trilobed longitudinally, the middle and most convex portion termed the "axis," and the lateral, lobes or pleuræ; each segment has the axis divided, in many genera, into a raised, posterior, exposed portion, and a depressed anterior articular portion, which is concealed under the preceding segment when the animal is extended, becoming visible as it rolls up, or on the fracture of the edge of the preceding ring; the *pleuræ* are straight or bent down at the end; in the latter case the end often "sharpened at its anterior edge for contraction," or provided with a triangular "*facet*," one of its sides parallel with the anterior edge, its base at the distal extremity, and its apex reaching about one third toward the axis, its thickened posterior margin joining the anterior margin of the segment at an obtuse angle, at the point where the end of the pleura begins to bend down, has, from its form, been called the "knee" by Pander Portlock, etc.; the same point has been by others termed the "*fulcrum*." In most cases a deep groove extends transversely from the axis along the middle of each pleura as far as the "knee," and then its extremity is often bent backward at an obtuse angle. I propose to term this the "*pleural groove*," and Dr. Burmeister suggests, with great probability, that the membraneous gill feet were attached to the corresponding ridge on the under side; caudal shield, or "*pygidium*," semi-elliptical, of one solid piece, axis and side lobes generally with transverse false segmental furrows, rarely corresponding in number on the axis and sides, and not admitting of independent motion.

Burmeister says, "That the Trilobites do not belong to any of the still living families of the crustacea, but represent a distinct group, most nearly related to the *Aspidostraca*; that their organization, however, exhibits pecularities, which at the present day do not occur together in one family, but are dispersed in several heterogeneous groups—while trilobites correspond in many essential points, if organization with the *Aspidostraca*, and are not related to any of the still living groups of crustacea, there are various important and even typical differences between them. These differences consist principally in the numerical proportions of the thoracic rings, since, although the latter certainly vary among the *Aspidostraca*, they may yet be reduced to several constant fundamental numbers (6, 9, and 12); whilst the trilobites only exhibit a constant number of rings for each separate genus, and the total number can not be reduced to certain, unchangeable, fundamental numbers, or numerical types. (In attempting to ascertain with certainity the number of thoracic rings, we certainly meet with the obstacles that we do not know, nor ever can know, the position of the sexual openings among the trilobites, which position alone indicates with certainty the boundary of the thorax, etc.) * * *

Trilobites, in point of the fundamental numbers of their thoracic rings are not constructed according to the law which we have discovered to obtain among all crustacea of the present world.

The earlier types of creation seem to present the various peculiarities of several groups passing into one another, resulting in forms, which exhibit in association, although incompletely the peculiarities now found detached and characteristic of very distinct groups. In proportion to the geological age of the extinct species, the running of the various typical forms into one structure is more marked, and therefore the peculiar and organic individuality and distinctiveness less obvious.

Prof. McCoy divided the family *Trilobitadæ* into five sub-families: 1st, *Agnostinæ* 2d, *Harpedinæ*; 3d, *Ogyginæ*; 4th, *Paridoxinæ*; 5th, *Asaphinæ*.

Third Sub family Ogyginæ.

Body flat, broad, oval; thorax as long as the head, four to eight thoracic segments; pleuræ flat, sickle-shaped, horizontal, having a pleural furrow not reaching the margin, ends not produced into spines; no facets, pygidium nearly as large as the head; eyes small or absent.

The *Ogyginæ* include the flat-sided trilobites not entering into the group of *Paridoxinæ*; unlike them, however, the body is very short and wide, and the pygidium, instead of being diminutive, is nearly as large as the head, giving a broad oval form to the body; the thoracic segments are only from four to eight in number, never facetted, and their extremities are never prolonged into spines.

This subfamily includes the genera *Trinucleus Lichas*, etc.

Genus *Trinucleus*—(LHWYD 1698).

Cephalic shield semi-circular, the limb broad and flat, with several rows of impressed, cup-like puncta on both surfaces; spines of the external angles very long; *glabella* pyriform, without lateral furrows; *cheeks* spherical triangles, without eyes or eye lines; generally a small spine on the neck furrows; *thorax* of six joints, lateral lobes twice the width of the axis, flat, straight, with parallel sides, slightly deflected at their free ends, pleural groove broad, shallow, not reaching the margin; pygidium triangular, with a deflected margin, axis with about seven segmental furrows, sides flat, with about six segmental divisions, each subdivided by a faint line toward the end.

Trinucleus Concentricus—(EATON, 1832).

Cephalic shield nearly semi-circular, the posterior angles produced into long, slender, straight spines, which reach half as far as the pygidium; glabella very prominent, broad, ovate, finely granulated; marginal fillet wide, regularly rounded and marked in front by three, four, or five rows of deep, rounded pores or punctures; these rows increase by one or two additional ones on the sides of the shield, and toward the lateral posterior angles are often irregularly scattered. Thorax with six segments; lateral lobes much wider than the axis. Pygidium three times wider than long, and obtusely mucronate.

It is extremely rare to find more than the cephalic shield and spines of this trilobite. Specimens showing the thoracic segments, though poorly, have, however, been found at and about Cincinnati. Its range seems to be from the lowest exposure of the rocks in the Cincinnati Group to about 250 feet above low water-mark at Cincinnati. In many places within this range the fragments of the cephalic shield, the punctured fillet and the spines are in great abundance, though good specimens of the cephalic shield and spines are not very common in the best localities.

Genus *Lichas*—(Dalman, 1827).

Body ovate, very flat; *surface* granulated; *head* semicircular; *glabella* large, semi-oval, with one long segmental furrow curving inward and downward from the upper third of the glabella on each side, nearly to the neck furrow, partially inclosing two large oval spaces, and close to the ends of the neck furrow a posterior pair of furrows inclose a very small trigonal lobe on each side; *neck segment* broader than the base of the glabella; *cheeks* small; *eyes* moderately large, reniform; *eye line* cutting the outer margin in front of the angles; *thorax* of ten segments, *pleura* flat, falcate, each with a fine slightly sigmoid pleural furrow, not reaching the margin; *pygidium* semi-oval, axis undefined, the latteral furrows, instead of encircling the end, converge about the middle, and diverge again toward the posterior margin, which they do not reach; two short segments at the anterior convex part; side lobe, flat, of two broad falcate ribs on each side projecting beyond the margin, each with a fine mesial duplicating groove; middle lobe semi-elliptical, pointed, a small divisional line coming off from the middle of the dorsal furrow on each side, curving downward and outward toward its extremity, so as partially to include an oval space on each side."

Lichas Trentonensis—(Conrad, 1842).

"Buckler ventricose, granulated or pustulate, somewhat fine-lobed;

glabella clavate, narrow behind, arched and expanded in front, extending beyond the center of the inner lateral lobe; pygidium composed of two or three articulations above, with a fourth and last, which is very long, and abruptly narrowing toward the extremity; lateral lobes with three articulations on each side, which are marked by a narrow groove for about one third of their length; central lobe separated from the lateral lobe by a deep, narrow groove."

This species is found very rarely about Cincinnati at an elevation of about 400 feet above low water-mark. A good specimen of either the cephalic shield, thorax, or pygidium is regarded as very rare. Its range is not known.

Fourth Subfamily Paradoxinæ.

Pleura, flat, horizontal, without facets, with a straight pleural groove, and terminating in spines inclining backward.

This subfamily is composed of a group of long-bodied trilobites, having for the most part large, cephalic shields, with the angles prolonged into spines, and very small, flat, caudal shields of few segments, none of them, I (McCo y) believe, can roll into a ball; their pleura are very wide and horizontal, not bent downward at the ends, so that the body is flat; they are destitute of facets, and have a long, straight, pleural groove extending their whole length, dividing each into two tumid portions, one or both of which are extended into long, sharp spines inclining obliquely backward. This latter character, of all the pleuræ terminating in separated spines, gives a peculiar physiognomy to the trilobites of this group. The thoracic segments vary from eight to twenty-three in number.

This subfamily includes the genera *Acidaspis*, *Ceraurus*, etc.

Genus *Acidaspis*—(Murchison, 1839).

"*Cephalic shield* wider than long, subquadrate or semi-circular, margin tumid, often spinous, lateral angles forming long, slender spines; *glabella* convex, narrow in front, not reaching the front margin, with two or three lateral lobes on each side, base prolonged backward into one or two long, thick spines; antennary pores usually distinct, close to the front of the glabella; *eye line* tumid, cutting the margin on each side in front of the glabella, and extending from the eyes, which are very small, to the posterior margin rather nearer the angles than the glabella on each side; *thorax* of eight joints, axis convex, narrow; *pleuræ* wide, perfectly flat, each with a nearly mesial pleural furrow parallel with the margin, the upper portion thickest, prolonged beyond the posterior, and terminating in a long spine, deflected at a considerable angle backward; *pygidium* small, semi-circular, axis very short, of two joints, sides flat, with but one segmental furrow, ending in a long spine at the margin of each side, the rest of the margin with many smaller spines."

Acidaspis crosotus.—(Locke, 1842,) as defined by Meek.

Body small, with a general subovate or sub-elliptic outline, rather distinctly convex; cephalic shield sub-semi-circular, and rather more convex than the body, apparently rounded in front, with the lateral angles produced into slender, mucronate, somewhat curved spines, that extend obliquely outward and backward to points opposite the fifth or sixth thoracic segment; glabella, including the neck segment, one third longer than wide, with an oblong sub-elliptic outline, the widest part being slightly behind the middle and between the eyes; lateral lobes, two on each side, of slightly oval outlines, with their longer diameters directed a little obliquely outward and forward, the posterior one being slightly larger than the anterior, while both are separated by as well defined furrows from the central, rather narrow part of the glabella, as they are separated from each other, or from the cheeks on each side; anterior lobe about as large as all four of the lateral lobes, twice as wide as the narrowed central part of the glabella behind it, and apparently rounded in front; between the lateral lobes and each eye a kind of outer or supplementary lobe, or protuberance, as large as each two of the lateral lobes, occurs; while from the outer side of each of these protrudes the small prominent palpebral lobe, which arrangement places the small eyes quite remote from each other; eyes unknown, but apparently small, prominent and directed laterally; movable cheeks not well preserved in the specimen studied, but apparently narrow, and sloping abruptly from the eyes laterally; neck segment comparatively large, prominent, with a central tubercle, and well defined by the neck furrow, which arches forward in the middle.

Thorax nearly twice as long as the cephalic shield, and about one fourth wider than long, exclusive of the produced extremities of the pleuræ, with its segments strongly arched upward, but not forward. Lateral lobes, comparatively, rather depressed, and rounding off gradually toward the lateral margins; pleuræ terminating in mucronate spines, directed outward and more or less backward, the posterior ones being longer, and directed more nearly backward.

Pygidium small, and with its mesial lobe composed of about three segments; lateral lobes consisting, apparently, of about three or four segments, each of which terminates in an acute spine, the lateral ones of which are larger than the others, and curved backward.

Entire surface, comparatively, rather coarsely granular, the granules being larger on the head than elsewhere; while on each of the pleuræ a larger granule or very minute tubercle occurs, at a point about half way out to the knee, or geniculation, at which latter point there is also some appearance of another, thus making two rows of these coarse granules along each lateral lobe.

Entire length, exclusive of the spines of the pygidium, about 0.25 inch; length of head, 0.08 inch; breadth, exclusive of lateral spines, 0.15 inch; breadth between eyes, 0.10 inch; length of thorax, about 0.11 inch; breadth of same anteriorly, exclusive of the extended ends of the pleuræ, 0.14 inch.

The specimen above described by Prof. Meek, belonging to Dr. C. A. Miller, was found at Ballface Creek, below Sedamsville. I found a specimen 0.40 inch in length back of Plainville. I also found specimens in the excavation for Columbia avenue, about 160 feet above low water-mark. Its range extends at least from low water-mark to 250 feet above and probably much more. It is, however, regarded as a rare fossil, especially in a good condition.

Acidaspis ceralepta—(Anthony, 1838).

This species is known only from the pygidium, which is sub-semi-circular in outline, and has two long, diverging spines, with six short digitations between them, and three on each posterior lateral margin.

Fragments of the margin of a cephalic shield, having much shorter spinous processes than the *Acidaspis Cincinnatiensis*, may belong to this species. It has been urged that the cephalic shields having a projecting spine from the base of the glabella, which are found about Cincinnati, belong to two different species; if so, one of them may belong to this species, the other one we know belongs to the *Acidaspis Cincinnatiensis.*

Acidaspis Cincinnatiensis—(Meek).

This species was described from a pygidium by Prof. Meek, on page 167, and engraved on plate 14, fig. 3, of the Ohio Paleontology.

From a specimen in the cabinet of Dr. H. H. Hill, I am enabled to throw some more light upon it. The specimen shows but little of the shell or exterior covering, but it is a good representation of the cast of almost every part of the body, and, from its appearance, there can be but little, if any, doubt that figures 3, 4, 6, and 7, on plate 14, of the Ohio Paleontology, belong to the same species.

The body is sub-circular in outline, granulous, and surrounded with spines; length, one and one tenth inches; width, nine tenths inch.

Cephalic shield more than twice as wide as long, margin thickened and spinous lateral angles, produced into long, slender spines. Length of cephalic shield, four tenths inch; width, nine tenths inch, and length of spines surrounding margin, one tenth inch. *Glabella*, with two lateral lobes on each side, and projecting posteriorly, showing where the spine attached, which projected back over the middle lobe of the trilobite.

The *glabella*, with this projecting spine, is the part of this trilobite most frequently found, and was known here by the name of *Acidaspis crosotus* (Locke) previous to the application of that name by Prof. Meek to another species. It is most likely that Prof. Locke described his species from fragments of this species, though he may also have had before him fragments of the form to which his name has been confined by Prof. Meek. It is better now to retain the names as suggested by Prof. Meek than to change them, because there is nothing lost by so doing. Prof. Meek suggested that if this spinous glabella should be found to belong to a species distinct from the *Acidaspis Cincinnatiensis*, it might be called the *Acidaspis Rhyncocephalus*, but, as it is now evident that it belongs to this species, the proposed name *Acidaspis Rhyncocephalus* may be striken from the list of names.

The thorax consists of nine segments, without the neck segment, each of which has a depression on the anterior margin, giving a double appearance; this forms an exception to all other species in this genus, which have only eight segments. The middle lobe is strongly convex, and $\frac{7}{20}$th inch in width. The lateral lobes are flat and the pleuræ terminate in spines about $\frac{3}{10}$th of an inch in length, which curve outward and backward. The anterior margin of the pleuræ terminate in a short spine. The length of the thorax is $\frac{1}{2}$ inch. The following is the description of the pygidium and part of the thorax, by Prof. Meek:

Pygidium, exclusive of its spines, about three times as wide as long, and approaching a sub-semi-circular outline; its anterior margin being straight all the way across, and about one third of its posterior margin in the middle transversely truncated, while on each side of this the posterior lateral margins are straight to the anterior lateral angles; mesial lobe prominent at the anterior end, where it is about as wide as each lateral lobe, but, becoming rapidly depressed and narrowed posteriorly, composed of only two well defined segments; lateral lobes flat, excepting a ridge that extends obliquely backward and outward from the anterior segment of the mesial lobe, across each, to the posterior lateral margins, where these ridges terminate in prominent, rounded, diverging spines; while the posterior lateral margins between these spines and the lateral angles are each armed with four smaller, slender spines, directed obliquely backward and outward. Four similar spines also occupy the truncated middle parts of the posterior margin between the two larger ones; surface smooth, excepting a few very minute, scattering asperities on the spines.

The pleuræ of the posterior thoracic segment are smooth, and have each a strong mesial ridge extending straight outward to the lateral extremity, where it curves abruptly backward and is produced into a long, sharp spine, extending as far backward as the longest spines of the pygidium, or farther.

Length of pygidium, exclusive of spines, 0.19 inch; breadth, 0.55 inch. Transverse diameter of first thoracic segment in advance of pygidium 0.70 inch, length of each pleuræ 0.23 inch; anterio-posterior diameter of the same 0.08 inch, length of larger lateral spine of each 0.38 inch.

Fragments of this species are found at all elevations, from low water-mark to the top of the hills back of the city, but they are most abundant in the lower 200 feet of the rocks. The specimen belonging to Dr. Hill was found in the marl in Eden Park, less than 200 feet above low water-mark.

Genus *Ceraurus*—(Green, 1832) as redefined by McCoy.

Cephalic shield granulated, semi-circular, lateral angles prolonged into spines; *glabella* clavate, reaching the front margin, gibbous, with three subequal, segmental furrows on each side, the basal one retroflexed; eyes small in the midst of the cheeks; *eye line* going from their base directly to the outer margin, which they cut considerably in front of the angles; thorax of eleven segments; *pleuræ* wider than the axis, each having its origin thickened into a large, oblong tubercle, cleft by a deep, diagonal, pleural sulcus; a little beyond this a small, rounded tubercle, beyond which the extremity is flat and falcately pointed; *pygidium* with a short, four-jointed axis, and the margin produced into three strong spines on each side, the anterior largest.

Chirurus of Beyrich is merely a synonym, and should therefore be suppressed.

Ceraurus pleurexanthemus—(Green, 1832).

Cephalic shield crescentiform, with a prominent connate articulation at the base, and the posterior angles extended into long curved spines; eyes small, distant, sublunate, granulated (not reticulated); glabella clavate, more or less convex, deeply four lobed on each side, leaving the front one broader; thorax with eleven articulations; pygidium with four (scarcely five) anchylosed articulations in the axial lobe, and three on each lateral lobe, the upper of these lateral articulations thickened and extended into a long, curved spine, the others terminating in blunt points; surface entirely papillose or granulated, the cephalic shield with scattered larger tubercles; two ranges of small papillose tubercles along the center lobe, and three ranges of mamuillary tubercles on each lateral lobe; labrum sub-trigonal in outline, convex in the middle, and granulous over the surface. A depression near the margin of two sides forms a marginal rim, from the terminations of which it attaches to the cephalic shield.

The whole surface, when perfect, is papillose. Upon all parts of the cephalic shield are interspersed small mamillary tubercles, and two similar ones on each articulation of the axial lobe, making two ranges of tubercles. Each articulation of the lateral lobes presents three large mammillary tubercles; the first formed by an oblique furrow from the upper side of the articulation, downward and outward; the third by a furrow from the upper edge downward and inward, or toward the axis; the meeting of these furrows leaves above them the second or middle tubercle.

A good specimen of this species is extremely rare, and even fragments are by no means abundant in any known locality. It is found at the quarries back of Cincinnati, at all elevations, from 300 to 450 feet above low water-mark. Probably the labrum is found the most frequently of any fragment of it.

Ceraurus icarus—(Billings, 1859).

General outline ovate sub-elliptic, moderately convex. Cephalic shield nearly semi-circular, rather more than twice as wide as long, regularly rounded anteriorly, and nearly straight behind, excepting near the lateral angles, where it curves somewhat abruptly backward, on each side, into the lateral spines, which are small, and scarcely extend farther back than to the second thoracic segment. Glabella, exclusive of the neck segment, about as wide as long, with its lateral margins so nearly straight and parallel as to make its breadth almost as great anteriorly as behind; separated from the cheeks by narrow but well defined furrows, that unite around the front, so as to leave a very narrow border between its anterior margin and that of the cephalic shield; lateral furrows well defined, and extending inward on each side, about one third the entire breadth; posterior lateral lobes a little smaller than the next two on each side in front of them, and sometimes nearly isolated by the furrows immediately before them, being so oblique as nearly or quite to run into the neck furrow before reaching the middle; succeeding two lateral lobes on each side, nearly transverse; anterior lobe larger, about twice as wide as long, rounded on each side, and somewhat straightened across the front. Neck segment well defined, arched upward, so as to be as high in the middle as any part of the glabella in front of it, and wider in the middle than at either end; neck furrow rather distinctly arched forward in the middle. Cheeks sloping anteriorly and laterally from the eyes, with the continuation of the neck furrow along their posterior margins strongly defined, straight, transverse, and terminating laterally some distance within the margins, where they meet nearly at right angles a furrow that passes forward on each side to the anterior end of the glabella; outside of the latter, a more shallow furrow also passes around the lateral borders. Eyes of moderate size, scarcely as prominent as the middle of the glabella, situated their own length in advance of the posterior margins of the cheeks, and nearly the same distance from the front of the same; visual surface a little arched, and showing under a good lens, when moistened, very minute reticulations, that seem to be mainly seen through the thin crust. Facial sutures starting at the middle of the anterior margin of the head, and cutting rather close around the anterior lateral corners of the glabella; thence extending backward, with a slight outward obliquity to the eyes, where they make slight curves (to form small, moderately prominent, palpebral lobes) to the posterior end of each eye; from which point they extend outward at first with a slight forward obliquity, after which they are deflected backward and outward, so as to cut the lateral margins a little in advance of the points where the continuations of the neck furrow along the posterior margins of the cheeks would intersect the same if continued outward.

Thorax about twice as long as the cephalic shield, nearly as wide anteriorly as long, and distinctly trilobate; axial lobe scarcely equaling the breadth of the lateral lobes anteriorly, and proportionally a little narrower behind, but rather distinctly more prominent and rounded; segments eleven, nearly transverse, and regularly arched upward. Lateral lobes a little flattened on top, nearly half way outward, at which point they slope off rather abruptly laterally; pleuræ straight and transverse for nearly half their length, where they are geniculated, obscurely subnodose, and curve downward and a little backward, to their falcate extremities, which lap upon each other in rolled up specimens, about half their breadth, each a little thickened and divided at its inner end, by a short oblique furrow, into two little subnodose prominences.

Pygidium small, transversely sub-elliptic, being twice as wide as long, and broadly rounded in outline behind; axial lobe small, and composed of three obscurely defined segments; lateral lobes large, and composed each of three segments, which terminate at the margin in moderately prominent, somewhat thickened digitations, the anterior of which are largest, somewhat carinate on top, and strongly curved backward, while the others decrease in size inward to the central two, which are smallest.

Surface finely and obscurely granulated, excepting that of the cheeks, which is sometimes marked with very small pits.

Length of the largest known specimen, 2.15 inches; length of head, 0.62 inch; breadth of head, 1.22 inches; length of thorax, 1.15 inches; breadth of thorax, 0.60 inch; length of pygidium, 0.37 inch; breadth of pygidium, 0.65 inch.

One or two good specimens have been found at Richmond, Indiana, and one or two other specimens in the upper part of the Cincinnati Group elsewhere, but it is so extremely rare that it will never ornament many cabinets.

Fifth subfamily Asaphinæ—(McCoy).

Pleuræ bent down at the end, and having distinct trigonal facets; thoracic segments eight to thirteen.

This subfamily may be looked upon as the type of the entire group, and contains the most perfectly organized trilobites. They all have the power of rolling themselves into a ball, and they are the only trilobites having the triangular facets at the anterior part of the extremities of the pleuræ. They have a compact, ovate form, and from the deflection of the margin all are of considerable depth.

This subfamily includes the genera *Asaphus*, subgenus *Isotelus*, *Calymene*, *Dalmanites*, *Triarthrus*, etc.

Genus *Asaphus*. (in a wider sense than Brong, by McCoy).

Head and tail nearly equal; *eyes* with a firmly fixed, thick cornea, with a smooth external surface; *facial suture* cutting the *posterior margin* of the cephalic shield within the lateral angles; *thorax* with eight to ten segments, having large facets, and distinct, wide, nearly straight pleural grooves, not reaching the margin; *glabella* indistinctly defined in front; *pygidium*, with the segments, usually indistinctly marked, the axis generally distinct and annulated, when traceable always elongate conic (of the ordinary type).

Contains the following subgenera: 1st, *Asaphus*; 2d, *Isotelus*.

Tracks of an Asaphus (?)

This figure ought, upon its face, to carry conviction that it represents the tracks made by the feet of some animal. There are, however, some additional facts that may be here stated. On the same slab, about two inches to the left hand of these tracks, there are four similar impressions, that seem possible to have been those of the left feet, if the figure shows the tracks of the right feet. On another slab there are as many tracks as those here engraved, which follow each other in the same order, as well as a number of tracks which indicate movements in other directions. I think it quite clear that there are too many marks of the same kind, which are regular in their order, to leave any reasonable doubt about their origin.

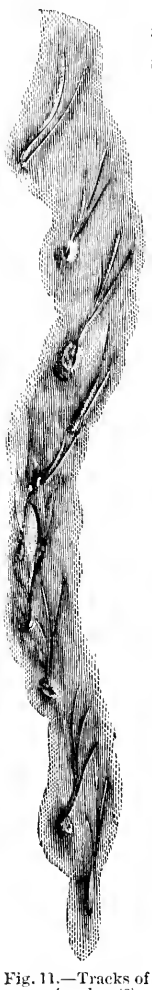

Fig. 11.—Tracks of an *Asaphus* (?)

They are presumed to be the tracks of a crustacean, because no animal of any other class known to the Silurian rocks could have made them. It being admitted that they are the tracks of a crustacean, the conclusion is inevitable that they are either the tracks of an *Asaphus* or of an unknown animal. If an *Asaphus* made tracks, and it is the opinion of naturalists that it did, or might have done so, they would have been as large as these, and, for ought that is now known, these are just such tracks as it would have made. While such is the probability, we would not, of course, resort to an hypothesis based upon an unknown fossil.

The foot seems to have been trifid more than two thirds of its length, and if webbed, as the impression indicates, would have been a good paddle for swimming. The posterior part of the foot, instead of leaving an impression, has left an elevation. This is an anomaly not easily solved, unless upon the hypothesis that the web feet were used generally for swimming, and not for walking, and that when used for walking, the folded web, at the posterior part of the foot, as the animal pressed forward upon the anterior part, drew the mud up after it, leaving a correct impression of the anterior part, and an elevated representation of the posterior part.

The specimens were found by C. B. Dyer, Esq., on shale, from an excavation on the west side of the Walker Mill road, in Cincinnati, about 100 feet above low water-mark, and are now in his collection. I do not know that any other person has been so observing as to find them.

Subgenus *Isotelus*—(DEKAY, 1824), as redefined by MCCOY.

Large elliptical; *buckler* semi-elliptical, with the angles rounded, or produced backward into spines; *Glabella* indistinctly defined; *eye lines* meeting at an acute angle at the front margin, thence diverging backward, slightly approximating again about the middle of their length, where the "*hiant*" eyes are situated, and again diverging to cut the posterior margin, near the angles; *thorax* of eight segments, axis as wide or wider than the lateral lobe, the ends of the pleural rounded with a strongly marked triangular facet and pleural groove; *pygidium* resembling the buckler in size and shape, trilobed and generally with a broad, smooth margin; axis and lateral lobes with fine segmental furrows or smooth.

Asaphus (subgenus *Isotelus*) *megistos*—(LOCKE, 1842).

The cephalic shield is anteriorly nearly perfectly elliptical, broadly and thinly margined, posteriorly arcuate, and terminated at the angles by spines or pointed processes, extending backward, beyond the two first thoracic segments. The eyes are prominent, large, furnished exteriorly, each, with a crescent-shaped cornea, and placed rather nearer to the posterior edge than to the outer margin of the shield. From the corner of each eye a sutural line extends forward, meeting at the anterior margin of the shield, and inclosing a lozenge-shaped, leaf-like frontal space. A thorax, with eight segments, middle lobe, sub-cylindrical; lateral lobes somewhat flattened, and descending abruptly at their lateral extremities, which are broad, flat, and rounded beneath, and admirably fitted to sliding over each other when the animal should contract or roll himself, according to a well known habit of the genus. Pygidium posteriorly elliptical, anteriorly circularly arcuate; length, horizontally, less than two thirds of the width, having two obscure, longitudinal depressions, continuous with the abdominal furrows, and converging toward an obscure posterior tubercle. The anterior outline of the pygidium exhibits three slight lobes (corresponding with those of the thorax), the two exterior of which are very distinctly marked by a transverse depression.

When the posterior shell of the tail is decorticated, an interior shell is exposed, which forms all around a deep trough, or "cavetto," beautifully marked with a "venalian" of eccentric curved and branched lines.

The above-named posterior tubercle is very nearly the focus of the elliptic outline of the *pygidium*, is just anterior to the marginal cavetto, and is the center around which the curved lines originate, each passing a little further back than the other, and advancing outward and forward, until they successively disappear on the anterior margin of the cavetto.

It is distinguished from the *A. gigas* by the aculeate processes or spines, by the perfectly elliptic terminations, by the simple (not raised) margin of the shield, and by the proportions of the *pygidium*, the *gigas* having the length four fifths, and the *megistos* three fourths only of the width. The latter is also much more prominent than the former, and the *pygidium* and sides much more abrupt in their descent.

Fragments are abundant throughout the blue limestone, from low water-mark in the Ohio to at or near the Upper Silurian, but a good specimen is extremely rare.

The fragments indicate that it sometimes reached 20 inches in length, and near 12 inches in breadth. The best specimens found do not generally exceed 3 or 4 inches in length. No locality can be pointed out at which a reasonably good specimen would be certain to reward a three days' search by a collector.

Asaphus (subgenus *Isotelus*) *gigas*—(DEKAY, 1824).

General figure oval oblong, with the sides rather straight, and entire surface finely punctate; head representing a spherical triangle, obtuse, or more or less rounded at the posterior extremities, convex, descending from between the eyes to the anterior border, which has a narrow, raised rim; eyes elevated, prominent, subpedunculated, strongly supported on the inner and concave side by a projection of the glabella; cornea oblong, lunated, highly polished; facial suture continuing from the center of the front, nearly parallel to the margin, until in a line with the eye, when it turns backward, and leaving the eye upon the maxillary portion, turns outward and backward, coming out at the base of the shield distant from the angle; thorax with eight articulations, the middle lobe about once and a half the breadth of the lateral lobes, the longitudinal grooves continued slightly into the buckler, and more distinctly into the caudal shield; the lateral lobes are rounded at their extremities, and flattened in such manner as to allow each lobe to slide easily under the lobe immediately preceding. Caudal shield subtriangular, convex, equaling the head in size, with the posterior termination rounded; on the central part, when decorticated, a slight elevation may be traced, which has the appearance of a continuation of the middle lobe.

It varies in size from less than an inch in length to 18 inches or probably more. Fragments abound throughout the blue limestone, from the lowest exposure to the highest. Good specimens are rare, though not so extremely rare as good specimens of the *megistos*.

There is a marked difference in the proportions that the head shield bears to the tail plate, and the tail plate to the abdominal sections in specimens of different sizes. This variation gave rise to the species *Isotelus planus* (De Kay), though it can be no more than a variety.

A rolled up specimen was described *Isotelus stegops* (Green), though from the description it does not seem to have presented any very great variation from a typical specimen.

Genus *Calymene*—(Brong, 1822).

Cephalic shield semi-circular, with a reflected anterior margin, and obtusely rounded lateral angles; *glabella* narrower in front than at base, sides marked with three maxillary furrows and tubercles on each side, the anterior smallest; *eyes* about the middle of the cheeks, reniform, prominent, strongly facetted; *eye line* advancing to the anterior margin, where being confluent with the marginal suture it joins that of the opposite side; over the eye it makes a small curve outward, defining a semi-circular eye lobe, from whence it extends to the lateral angles, which it bisects on each side; *thorax* of thirteen rings, axis very convex, lateral lobes wider than the axis, bent down at their ends with large facets, each with a strong pleural groove, angularly bent down and confluent at its end with the posterior margin; *pygidium* narrower than the buckler, semi-oval, with distinct seven, nine, or eleven joints, prominent axis, and broad convex, lateral lobes, the segments of which are flat, about equal to the axial in number, and divided by a sulcus at their ends.

In a wider sense, by McCoy, it is described as follows:

Lateral angles of the head obtusely rounded, exactly bisected by the facial sutures; eyes small, "*hiant*;" *glabella* narrower in front than at the base; *thoracic segments* thirteen.

These trilobites differ remarkably from *Phacops* in the structure of their small eyes, which are seldom or never preserved, seeming to have been of so delicate a nature as to fall out on the animal's death, leaving a hole in the cephalic shield, where they were set, whence Dalman's term "hiant." The head differs from *Phacops* in its blunt, lateral angles, and the glabella being wider at base than in front, and in the course of the eye line; the body differs, in having thirteen instead of eleven segments.

Calymene senaria—(Conrad, 1841).

Cephalic shield semi-circular or sublunate, regularly rounded in front, or slightly projecting in front of the glabella, with a distinct thoracic ring at the base; posterior angles sub-acute or rounded; glabella separated from the cheeks by a deep, broad groove, wider behind, or often of nearly equal width throughout, with three tubercles or lobes on each side, the anterior one often obscure; cheeks triangular; eyes truncate conical, situated a little outward from the inner edge of the cheek; facial suture terminating nearly in front of the eye; thorax with thirteen segments, those of the lateral lobes with a deep groove extending from the base more than half way to the extremities; pygidium small, with seven segments in the middle lobe, and five in each lateral one, the latter with an impressed line or shallow groove the whole length.

It is found throughout the entire exposure of the Cincinnati Group of blue limestone, at all elevations. It is sometimes rolled up and sometimes extended. It varies in size from an eighth of an inch in length to 2¼ inches. Good specimens are much more abundant than those of any other species of trilobites, though in many places only fragments are to be found.

Some specimens are closely covered with tubercles, as those found at the cutting for Columbia avenue, and at other places, from low water-mark to 200 feet above, while they are smooth generally and appear never to have been tuberculous in the higher rocks, though this is, according to Burmeister, the result only of having lost the tuberculous covering. Different specimens present different proportions in many parts of the body. The anterior part of the cephalic shield is much longer and projects farther up in some specimens than in others, while some are longer in proportion to their width than others, and differ in other minor particulars.

The *Calymene callicephala* (Green), described in 1832 in Green's Monograph, and sold as cast No. 2, was, in my judgment, a large specimen of this species. I come to this conclusion from the description, the place where found being the Cincinnati Group, and from the engraving in Burmeister's Monograph of trilobites; indeed, I do not believe there is any doubt about it. I know no reason why the fossil should not retain the name *callicephala* (beautiful head), instead of the name *senaria*, nine years later, and much less expressive. But the paleontologists of the whole country seem to have adopted the name *senaria*, and as there may be some reason for it that I do not understand, I have retained that specific name instead of *callicephala* (Green), in deference to their action or judgment, as the case may be, and against my own opinion of what ought to be the rule of action.

Calymene Christyi—(Hall).

General form elongate ovate, symmetrical; body gibbous, the pygidium equaling the length of the head. Head semi-circular, the frontal border expanded, and gradually narrowing on the sides; the posterior angles terminating in a short, sharp spine. Glabella wide, slightly narrowing toward the front, regularly convex, strongly defined by the dorsal furrows, a little concave in the middle of the base; occipital furrow well defined, nearly straight, and in right line with the cheek furrows; posterior furrow oblique, defined, but not deep; the middle one nearly rectangular to the axis, while the anterior one is but slightly indented. The posterior lobe is much wider than the middle one, and about the same width as the anterior one. Cheeks small. Eyes very prominent.

Thorax with thirteen segments; the axis salient, and a little wider in the middle than the lateral lobes; the articulations of the latter flat, or slightly curving, for a little more than one third their length, when they are suddenly bent downward.

The pygidium is gibbous, semi-elliptical, with the axis very prominent, and marked by seven or eight rings, the last one being longer and more prominent, with a minute, scarcely defined node at the extremity; lateral lobes marked by six flattened ribs, the last one of which is minute, the expansion being continued in a narrow, flattened border around the posterior extremity.

It is distinguished by the form of the glabella and the shallow furrows which leave the lobes flattened, and not convex and rounded, and and by the minute spine at the posterior angle of the head shield.

Found near Oxford, in the upper part of the Cincinnati Group, and named in honor of Prof. Christy.

Genus *Dalmanites*—(Emmerich, 1845).

"General form, *buckler*, *glabella*, *eyes*, and *eye lines*, as in *Phacops*, but the latter lobes of the glabella more equal; not contractile; *thorax* of eleven segments; *pleuripedes* curved backward, and generally pointed at their extremities, facets very long, narrow rhomboidal, slightly defined; pleural groove strong, slightly sigmoid and oblique (not angulated); pygidium elongate, generally pointed, axis with from twelve to twenty-two segmental furrows, sides with fewer (about half the number) strong ribs, usually duplex, confluent at their ends with the thickened entire margin; hypostoma with a dentate edge."

Dalmanites Carleyi—(Meek, 1872).

Cephalic shield about twice as wide as long, rounded in front, and more or less straight behind, so as to present a nearly semi-circular outline, exclusive of the produced posterior lateral extremities; which are about as long as the glabella, rather broad anteriorly, and tapering rapidly to the posterior ends. Glabella wide in front and rapidly narrowed behind, defined by a moderately distinct furrow on each side, and not very prominent at any point; anterior lobe comparatively large, transversely elliptical or sub-rhombic; lateral lobes small, and separated by furrows that extend inward, so as to leave only a very narrow central space; anterior pair each sub-trigonal, about twice as large as the middle lobe, which is transversely ovate, while those of the third or posterior pair are smallest; neck furrow moderately well defined, and continued as posterior marginal furrows of the cheeks nearly to their outward margins; occipital segment comparatively rather wide anterio-posteriorly, and elevated and convex in outline behind; palpebral lobes ascending and narrowing rapidly outward to the summit of eyes. Cheeks sloping laterally from the eyes, rather abruptly, to a shallow marginal furrow, that is continued so as to form a very narrow margin around the front of the glabella. Eyes moderately large, situated full half their length from the posterior margins of the cheeks, and elevated somewhat above the height of the glabella, truncato-subconical in form, the visual surface curving round, so as to form about three fourths of a circle at its base; lenses of comparatively moderate size, showing about seven in a vertical row at the middle, and twelve or fourteen in the longest oblique rows; surface of anterior lobe of glabella showing small obscure granulations; other parts of the cephalic shield nearly smooth, or less distinctly granular.

Length of cephalic shield, exclusive of the posterior lateral spines, 35-100th inch, including do., 60-100th inch; breadth, 67-100th inch; anterio-posterior diameter of eyes, 12-100th inch; height of same on outer side, 8-100th inch.

Thorax with eleven segments, axial lobe strongly convex, lateral lobes flattened, pleuræ curved backward and obtusely pointed at their extremities; gradually tapering from the neck segment to the pygidium. Length of thorax, 6-10th inch; greatest breadth, 7-10th, and tapering to 5-10th inch.

Pygidium sub-trigonal, rather depressed, as wide as long, very narrowly rounded or almost sub-angular behind; the posterior extremity being curved a little upward; mesial lobe depressed, but a little more convex than the lateral, and of about the same breadth, or slightly narrower at the anterior end, and narrowing to the posterior extremity, which does not reach the margin, composed of about thirteen distinct segments, and two or three other very small, obscure ones behind these; lateral lobes separated from the mesial lobe by moderately distinct furrows, and sloping off gently, with slight convexity of outline, to the lateral and posterior margins, showing each, about thirteen segments, which are not furrowed, and extend very nearly, but not quite, to the margin, the smaller posterior ones being directed very obliquely backward; surface showing rather fine, irregular, scattering granules.

Length of pygidium, $\frac{42}{100}$th inch; breadth, $\frac{48}{100}$th inch.

Found at Cincinnati, from 300 feet above low water-mark to near the top of the hills. Extremely rare. Dr. R. M. Byrnes has a fine specimen, rolled up, and Prof. Harper has a fine specimen, extended.

Dalmanites breviceps—(Hall, 1866).

Body broadly ovate in general form, its greatest width across the base of the cephalic shield. Head sub-crescentiform, the anterior margin very slightly produced in front of the glabella. Frontal lobe of glabella transversely elliptical, the breadth nearly twice as great as the length; separated from the anterior lobe by deep, narrow furrows. Anterior lobe transversely subovate, prominent; middle and posterior lobes obsolete, occipital ring narrow, distinctly defined.

Eyes very prominent, with five lenses in the central, vertical range, but the number of vertical ranges can not be determined; palpebral lobe depressed. The outer border of the movable cheeks is thickened and rounded, and the space between the border and the eye depressed. The posterior spines long and broad, reaching to the sixth thoracic segment.

Thorax with the axial lobe highly convex, and the lateral lobes strongly geniculate, subequal in width, rapidly tapering posteriorly from the fourth or fifth segments. Segments curved forward on the top of the axial lobe, and the furrows on the pleura strongly marked.

Pygidium obtusely pointed behind, the lateral borders inclosing an an angle of about 120°, the anterior border rounded; the number of articulations not clearly defined, but apparently numbering about ten or twelve, besides the terminal one; those of the lateral lobes have been more numerous. The entire surface finely pustolose.

Not found at Cincinnati, but found in Warren county, in the upper part of the Cincinnati Group. Sometimes found rolled up and sometimes extended. Extremely rare.

Genus *Prœtus*—(Steininger, 1831).

Cephalic shield semi-circular, surrounded by a thickened margin; the posterior angles do not project perceptibly; the glabella is very convex, parabolic, rounded at the anterior part, undivided, without any lateral lobes; at the posterior part it is as broad as the margin, to which it is immediately joined. The facial suture projects over the anterior cephalic margin on a line with the eyes, is thence directed toward the eye, forms the covering plate, and runs at first straight, afterward in an S-shaped curve, to the posterior margin, which it penetrates beyond the center, in an oblique direction toward the external part. *Eyes* of moderate size, very prominent, smooth, joined rather closely to the glabella. Body axis ten-jointed, the joints gradually more narrow toward the posterior part, strongly arched, abruptly separated from the lateral lobes by a peculiar furrow, these lobes having an oblique indentation.

"Caudal shield corresponding with the cephalic, but smaller, the axis highly arched, short, distinctly articulated, the sides furnished with slight furrows or obsolete ribs, the margin even, but having a very acute angle. The surface of the shell almost smooth, but with distinct traces of granulation on the glabella, and on the cheeks beneath the eye."

Prœtus parviusculus—(Hall, 1866).

Body, in general form, broadly ovate, widest across the base of the cephalic shield. Head sublunate, produced into long, sharp spines at the posterior angles of the cheeks. Glabella elevated, broadly subcomical, rounded in front, concave behind; furrows not visible.

Eyes comparatively large and prominent, separated from the glabella by a somewhat deep groove; border of the head broad and flattened.

Thorax having the axial lobe very prominent, narrower than the lateral lobes; segments scarcely arching forward in the middle; lateral lobes geniculate, and having the extremities of the pleura directed backward and distinctly furrowed to near their outer extremities.

Pygidium small, semi-circular, regularly rounded behind, and the anterior margin straight to near the lateral angles, where it is abruptly curved backward. Axial lobes narrow, not reaching to the posterior border of the shield; marked by five small annulations, with about the same number on the lateral lobes, which are less distinctly marked. Surface smooth or very finely granulose.

This species has been found at Cincinnati, but only two specimens that I am aware of. They were both found near the top of Vine street hill.

Prœtus Spurlocki—(Meek, 1872).

General form, exclusive of the spines of the cephalic shield, ovate sub-elliptic, with moderate convexity. Cephalic shield having the form of one of the halves of an ellipse divided through its shorter diameter, its posterior margin being straight, and its anterior narrowly rounded; posterior lateral angles produced into long, sharp spines, that extend back nearly or quite the entire length of the thorax; glabella nearly one third the breadth of the posterior part of the head, separated from the cheeks on each side by a well defined furrow, but without having the neck furrow distinctly marked; other details of glabella unknown. Eyes sublunate, nearly their own length in advance of the posterior margins of the cheeks.

Thorax having eight segments. Mesial lobe moderately prominent, scarcely equaling the breadth of the lateral lobes anteriorly, and tapering more rapidly backward, with its segments not arching forward. Lateral lobes less convex than the middle one; pleuræ nearly straight and transverse, or very slightly curved backward, and furrowed for a little more than half way out with their extremities rounded in front, and nearly rectangular behind.

Pygidium sub-semi-circular, about one half as long as the cephalic shield, and provided with a smooth, flattened margin. Mesial lobe moderately prominent, narrower than the lateral; tapering posteriorly, where it terminates rather abruptly, without passing quite upon the flattened margin, showing only very obscure traces of five or six segments on its anterior half. Lateral lobes more depressed than the mesial one, and with their flattened margin rather more than one third the breadth of the anterior end of each, and each showing obscure traces of six or seven furrowed segments.

Entire surface smooth. Length of a specimen, 0.54 inch; breadth at the widest point across the posterior part of the head, 0.25 inch; length of head, 0.27 inch; length of pygidium, 0.11 inch.

The specimen belonging to Dr. H. H. Hill was found in the excavation for Gilbert avenue, in Eden park, about 180 feet above low-water mark.

Genus *Triarthrus*—(GREEN, 1832).

General form, an elongated ellipse, rather pointed at the tail; cephalic shield somewhat semi-circular, deeply trilobate, rounded off laterally without projecting spines; glabella of equal width from base to front, trilobed on each side, rounded and convex in front, neck segment distinct. Thorax with thirteen segments, middle and lateral lobes of equal width, axial lobe convex, with a central row of minute spines; pygidium obtusely semi-circular, with six or seven segments.

The name was from the three articulations in the glabella, then supposed to be the three articulations of the abdomen.

Triarthrus Becki—(GREEN, 1832).

General form, an elongated ellipse, narrower at the posterior extremity, sides somewhat straight; cephalic shield broadly semi-oval, rounded on the margin posteriorly; glabella of equal width from base to front, rounded and convex in front and deeply trilobate on each side, prominent thoracic ring at the base, having a minute spine on the middle of the central lobe; side lobes narrowing and pointed in front; eyes indistinct, situate at the point of union between the side lobes and the margin anterior to the third lobe of the glabella; thorax with thirteen segments, lobes of equal width, and narrowing toward the pygidium; axial lobe convex, and having a short spine or prominent tubercle on the back of each segment, forming a row of spines from the neck segment to the pygidium; lateral lobes somewhat flattened, each segment deeply grooved along the middle, and obtusely pointed; pygidium with seven segments in the middle lobe and five in the lateral lobes; posterior extremity obtuse. It varies in size from half an inch to one and a half inches in length.

In Mr. Dyer's collection there are some very good specimens, found while excavating for a well in Fulton, now a part of Cincinnati, at an elevation of fifty or sixty feet above low water-mark. It has been found in the bed of Taylor's creek, just below an old mill-dam, above Newport, Kentucky, at an elevation of about fifty or sixty feet above low water-mark. I found a fragment on a rock up Taylor's creek, above where the Alexandria pike first crosses it, at an elevation of about 150 feet above low water-mark. Good specimens ornament but few cabinets, though a great deal of search has been made for them.

Genus *Cypricardites*—(CONRAD, 1841).

Equivalved, profoundly inequilateral; hinge with four or five unequal cardinal teeth, anterior one largest and most prominent; lateral teeth short and very remote from the cardinal teeth.

Cypricardites Hainesi—(S. A. MILLER).

Equivalve, inequilateral; margins subparallel, diverging posteriorly; beaks sharp, projecting over the hinge line and slightly incurved;

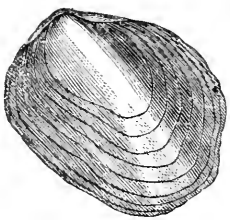

Fig. 12. *Cypricardites Hainesi.*

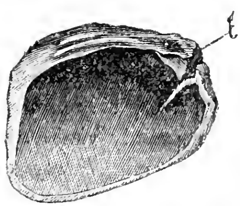

Fig. 13. Interior of the left valve.

umbones sub-angular, with a ridge extending posteriorly and curving toward the base, where it becomes obsolete; cardinal teeth unknown; lateral teeth two, one much longer than the other; muscular impression below the beak anteriorly.

The cardinal teeth, in the valve, figure 13, being destroyed, as shown by the letter *t*, the number and character could not be ascertained.

Surface marked by fine concentric lines.

Length $1\frac{3}{20}$ inches; width $\frac{19}{20}$ inch; greatest depth through the umbones $\frac{12}{20}$ inch.

The specific name is given as a compliment to Mrs. M. P. Haines, an earnest and devoted naturalist of Richmond, Indiana, who has collected a very fine cabinet and studies to appreciate it.

Locality and Position.—I found the specimens about a mile below Richmond, Indiana, at an old quarry, near the top of the hill, in a field on the east side of the creek. Not observed elsewhere, so far as known.

Streptorhynchus (?) Hallie.—(S. A. Miller.)

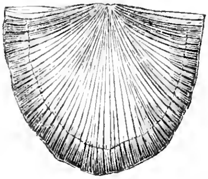

Fig. 14. *Streptorhynchus(?) Hallie.* Dorsal valve.

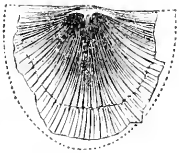

Fig. 15. Interior of dorsal valve.

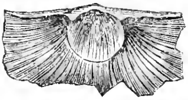

Fig. 16. Interior of ventral valve.

Shell sub-trigonal in outline, concavo-convex, deflected laterally, resupinate, rather thin and frail; hinge scarcely equaling the greatest breadth of the valves; length and breadth about $\frac{3}{4}$ of an inch.

Dorsal valve convex in the central part, flattened on the umbone and deflected laterally; surface marked by moderately coarse, radiating striæ, which increase by intercalation of smaller ones; area linear, beak not distinct from the edge of the area. Interior, showing cardinal process to be very small and divided into two teeth-like parts, directed a little forward and flattened on their faces; socket ridges small, short, and oblique; mesial ridge scarcely perceptible, without a magnifier, radiating striæ plainly visible.

Ventral valve moderately concave in the central and anterior regions, but slightly convex at the beak, which is perforated and projects slightly beyond the edge of the area; surface marked by radiating striæ, which increase by even bifurcations; area narrow and sloping laterally; foramen closed by a rounded deltidium for the reception of the cardinal teeth of the dorsal valve. Interior showing trigonal hinge and circular cavity; marked by radiating striæ.

This species belongs to the same genus that the shells commonly known as *Strophomena filitexta*, *S. subtenta*, *S. planumbona*, *S. planoconvexo*, etc., belong to. They are not, however, included in the genus *Strophomena*, and Prof. Hall has suggested that they might be placed in the genus *Streptorhynchus*, while Prof. Meek would leave them in the genus *Hemipronites*. The probability is that a new genus should be formed to include them and a few other species.

The specific name is given as a compliment to Miss Hallie Cotton, who was the first lady to join the Cincinnati Society of Natural History, and at a very early age has developed a remarkable taste for natural science.

The specimens were found in the excavation for Columbia avenue, about 150 feet above low water-mark. Not observed elsewhere so far as known.

Modiolopsis modiolaris—(Conrad, 1838).

Somewhat obliquely oblong ovate, narrowed before, expanded and obliquely truncated posteriorly; basal margin usually contracted or slightly arched upward; cardinal line extended straight or slightly curved; beaks moderately prominent near the anterior extremity; an oblique, scarcely defined ridge, extending to the posterior basal margin; surface marked by concentric undulations; muscular impression distinct, close to the anterior extremity.

The hinge line of this species and the internal markings never having been illustrated, I have caused to be engraved the following figure:

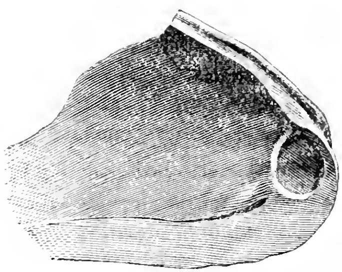

Fig. 17. Hinge line and internal structure of *Modiolopsis modiolaris.*

The hinge line is toothless, and marked by a ligamental depression, commencing just anterior to the beak and extending to the posterior part of the shell. The external ligament was situated between and anterior to the beaks, and extended posteriorly to the end of the hinge line. The muscular impression is circular and deep, and situated immediately below and subanterior to the beak, and not anterior to it, as appears in the cast. A mesial ridge extends from the beak to the base of the shell, separating the muscular impression from the umbonal cavity. Pallial line distinct, and marked by irregular pits.

The beak of the shell scarcely extends beyond the hinge line, and is less prominent than it would appear, judging from the cast alone.

This species is quite common on the hills back of Cincinnati, and has an extensive range, but it is very rare to find anything more than a mere cast. It is found quite common from 300 feet above low water-mark to the rocks of the Upper Silurian, and is rarely found below 300 feet above low water-mark.

Modiolopsis Versaillesensis—(S. A. Miller).

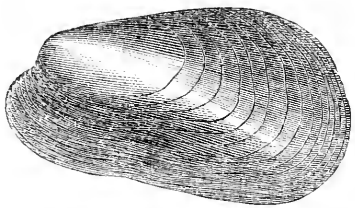

Fig. 18—*Modiolopsis Versaillesensis.*

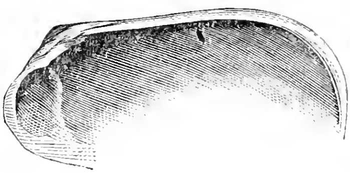

Fig. 19—*Modiolopsis Versaillesensis.* Hinge line and muscular impression.

Equivalve, inequilateral, oblong, expanded and compressed posteriorly; basal margin contracted or arched upward, below the beaks; cardinal line straight; beaks near the anterior extremity, and slightly more prominent than those of the *Modiolopsis modiolaris;* umbones subangular and extending obliquely, posteriorly; surface marked by concentric lines; muscular impression circular and deep, below and anterior to the beak; mesial ridge between it and the umbonal cavity; hinge line plain and smooth, except a slight ligamental depression below the beak.

Length of specimens examined varying from $\frac{3}{4}$ inch to $2\frac{1}{2}$ inches; breadth and thickness in proportion to length.

This species differs from the *Modiolopsis modiolaris,* in having a more prominent beak, more angular umbones, different hinge line, and ligamentary attachments, and in having the muscular impression farther anterior to the beak. Casts of the two species might not be distinguishable from each other.

This species was found by me at Versailles, Indiana, about 300 feet below the rocks of the Upper Silurian, and associated with *Anomalodonta gigantea, Anodontopsis* (?) *Milleri, Pleurotomaria tropidophera, Tellinomya occidentalis,* etc.

Descriptions of one new species of Leptæna, and two species of Cyclonema from the Lower Silurian Rocks. Cincinnati Group. BY U. P. JAMES.

Leptæna Aspera.—JAMES.

[*Leptæna rugosa.*—JAMES. Catalogue of L. Silurian Fossils, 1871.]
[*Leptæna sericea* (?)—MEEK. Pal., Ohio, 1873.]

[*Aspera*, in reference to roughness.]

Shell small, transverse; width nearly twice the length; hinge line generally about equal to the greatest width of the shell farther forward—in some individuals more—and sharply pointed at the extremities (nearly all of the uninjured specimens taken directly from the clay bed have the extremities of the hinge line thus pointed); lateral margins rounding quite abruptly to the front.

Dorsal valve concave, the slope dropping, in most cases, nearly at right angles under the beak and about half the length of the cardinal line, in others the slope is gradual; beak not projecting; area narrow, drooping forward; cardinal line straight, and having a crenulated appearance, most conspicuous when held to a strong light; wrinkles commencing at the hinge line and extending inward, obliquely, crossing the striæ at nearly right angles.

Ventral valve moderately convex on the umbone; cardinal line sloping slightly from the beak to the lateral extremities; beak not incurved; cardinal area much the widest in the middle, and nearly parallel to the plane of the valves; foramen triangular, appearance of crenulations as in the other valve; wrinkles not so plain.

Surface of both valves marked by fine radiating striæ, about every fourth or fifth one stronger than the others, which extend from the hinge line about two thirds or three fourths of the distance to the free margins, where they are interrupted by rough elevations (generally most so on the ventral valve), continuing to the edge of the valves, which are much thickened up. This roughness does not extend in all cases to the lateral margins, *immediately in front* of hinge line, and in the dorsal valve it is sometimes entirely wanting. It is found on the small, young shells as well as old ones.

Figures referred to this species are published in the Pal. of Ohio, vol. i., part 2, plate 5, *3f* and *3g*, but they do not show the rough surface; the radiating striæ being made to continue to the free margins.

Leptæna rugosa (a synonym) was pre-occupied for another shell—now known as *Strophomena tenuistriata* (Sowerby)—hence the change of name.

Length of some large specimens about half an inch, breadth one inch; others are nearly as long as broad.

The typical form was found about 150 feet above low water-mark of the Ohio River, at Cincinnati, but varieties are found at other localities all through the Cincinnati Group.

Cyclonema pyramidata—(JAMES).

[*Cyclonema pyramidata.*—JAMES. Catalogue of Lower Silurian Fossils, 1871.]

Shell obliquely pyramidal; broader than high; base expanded; slope from apex to base quite regular; volutions four, flat or slightly depressed; suture shallow; a narrow, angular shoulder on the upper edge of the first volution, in some cases; surface ornamented by revolving lines, about every fourth one, on the body whorl, much stronger than the ones between, crossed by fine striæ or lines of growth, having a backward direction; on the upper whorls every other one of the revolving lines stronger than the intermediate one. The body whorl makes a large portion of the shell; slope of the under side to the outer lip sharply rounded, to the inner lip and umbilicus nearly flat, or rounding inward; inner lip, of old specimen, thickened; outer lip thin, and sharp at the edge, and slightly projecting at the junction with the outer line of the volution. Aperture rounded, or suboval.

Breadth of a medium size specimen, 14 lines; height, 11 lines.

This shell bears some resemblance to *C. bilix*, Conrad, but it is much more expanded at the base, and the volutions are flat or slightly depressed, whilst in *C. bilix* they are more or less inflated, and the suture deeper, and the outline quite different.

Position and Locality.—Cincinnati Group, about 350 or 400 feet above low water-mark of the Ohio River, at Cincinnati; but it may be found at other localities and at different horizons.

Cyclonema fluctuata—(JAMES).

[*Cyclonema fluctuata.*—JAMES. Catalogue of Lower Silurian Fossils, 1871.]
[*Cyclonema bilix var. lata.*—MEEK. Palæontology of Ohio, 1873.]

[*Fluctuata* referring to the wavy surface.]

Shell turbinate, depressed; breadth greater than the length; volutions four or five increasing rapidly in size, the first one flattened on the under side; aperture suboval, oblique; suture broad and deep; inner lip thickened, outer lip thin and sharp. Surface marked by revolving lines, varying in size and distinctness, in some examples being sharp and prominent, in others scarcely visible to the naked eye, crossed by fine striæ, or lines of growth, which, to the sharply defined ones, give the shell a beautifully ornamented appearance. Volutions with oblique undulations, and a broad revolving depression near or above the center, most conspicuous on the body whorls, sometimes extending to the apex.

Height of a large specimen about 1¼ inches, breadth 1½ inches. Small ones, less than ⅝ths of an inch in height and breadth.

The above is the typical form, but examples are found varying gradually to a narrow body whorl, narrow, shallow suture, and conical form, and decidedly longer than wide; all having the peculiar wavy or undulating surface more or less distinct, with other features in common, so that it is impossible, or very difficult, to find a dividing line.

Figures *5e*, *5f*, and *5g*, plate 13, Palæontology of Ohio, vol. i., part 2, show the extremes of this species.

Position and locality: Lower Silurian formation, upper part of the Cincinnati Group, Warren and Clinton counties, Ohio, and other localities in Ohio and Indiana.

Nullipores—(U. P. James.)

I have occasionally found, during years past, a thin substance covering surfaces of our fossil corals, clusters of crinoidal columns, etc. (of the Cincinnati Group), that Palæontologists, whom I have consulted, could not explain. The following extract from Dana's work on Corals and Coral Islands, published 1872, seems to throw some light on this obscure fossil form:

"*Nullipores.*—The more important species of the vegetable kingdom that afford stony material for coral reefs are called Nullipores. They are true Algæ, or sea-weeds, although so completely stony and solid that nothing in their aspect is plant-like. They form thick, or thin, stony incrustations over surfaces of dead corals, or coral rock, occasionally knobby or branching, and often spreading lichen-like.

"They have the aspect of ordinary corals, especially the Millepores, but may be distinguished from these species by their having no cells, not even any of the pin-punctures of those species.

"Beside the more stony kinds, there are delicate species, often jointed, called *Corallines*, which secrete only a little lime in their tissues, and have a more plant-like look. Even these grow so abundantly on some coasts, that, when broken up and accumulated along the shore by the sea, they make thick calcareous deposits. Agassiz has described such beds as having considerable extent in the Florida seas."

* * * * * *

"Though in the midst of the breakers (the reef of the coral atoll), the edge stands a few inches, and sometimes a foot above other parts of the platform; the incrusting *Nullipores* cover it with varied tints, and afford protection from the abrading action of the waves."

There are no coral *reefs* in the *Cincinnati Group*, so far as now known, but the Nullipores attach themselves to dead corals under other conditions.

Method of Rearing Lepidoptera—Entomological Memoranda. By A. G. WETHERBY.

The writer having had some experience in rearing various species of *Lepidoptera*, offers in the following pages an account of the method employed, hoping it may be of service to those who desire to become better acquainted with the habits and transformations of this most interesting and beautiful division of insect life.

In the study of *Lepidoptera*, as in the study of everything else, close acquaintance with the object studied *is of the first importance*, and this can only be had when the species are under the eye at all times. It is a fact, not so well known as it should be, that by imitating natural conditions so far as they are favorable, and avoiding them so far as unfavorable, insects may be reared in much greater perfection than they grow native, as too great heat, too much wet, drouth, violent agitation by storms, and other vicissitudes to which they are exposed in a state of nature, may be almost wholly avoided, and the entire life of the insect become a period of undisturbed and quiet growth.

In order to insure such success, *the first essential is a good breeding cage*, or vivarium. Having tried various plans, I now offer one which will meet all requirements, and which any handy boy of twelve or fourteen years can construct for himself, at an outlay of one dollar or less.

Get *two pieces* of inch pine or poplar board, *two feet* long and *sixteen inches wide*, and *four pieces* one and one half inch square, and twenty inches long. To one side of one of the pieces of board nail two strips of inch stuff, "*across the grain*," near the ends, to prevent the board from warping, and to serve as the feet of your cage. To each corner of the other side nail one of the four pieces above mentioned. You now have the bottom and corner posts of your cage. To the other end of these posts nail the other board, and the frame of your cage is complete. Now stretch good mosquito netting around both sides and one end of your frame, fastening it with leathered tacks to the edges of the top and bottom board, and also to the corner posts. The cage is now finished, except the door, for which make a frame of the same size as the end of the cage left open; stretch the mosquito netting over this frame, hang your door to one of the corner posts by leather hinges of the proper length, and your apparatus is all complete. It only remains to find the larvæ on their food-plants; place branches of the food-plant in jars of water, cover the top of the jar with cotton, to prevent the larvæ from crawling down into the water, put them on their food, set them in the cage, and you have nothing to do but watch them feed, moult and grow, until they are ready for the final change to the chrysalid state. Of course the food must be renewed as often as it becomes in the least degree withered and stale.

In such a cage as the one described the writer has reared great numbers of many diurnal *Lepidoptera*, as well as the nocturnal and crepuscular species.

All lepidopterous larvæ, when about to assume the pupa state, change color, become restless, refuse food, and those that undergo their transformation in the ground leave the food plant and wander uneasily about the bottom of the cage. *These signs should never be disregarded*, as they show an effort of instinct to find a suitable locality in which to undergo the wonderful change from the larval to the pupa stage. The larvæ of *Eacles imperialis* (Hübner), one of our largest and most beautiful of nocturnals, which is of a bright green color during the feeding season, in a few hours changes to a dirty brown along the back and sides; the feet lose the power of holding to the branches of the food plant; the skin of the insect becomes stiff and horny; it descends to the bottom of the cage, and crawls clumsily around, seeking an outlet for escape. The same facts, in different degrees, may be noticed of nearly all species. When this is the case, fill a large earthen jar or wooden bucket two thirds full of mellow loam; put your larvæ into the vessel, tie a piece of mosquito netting over the top or invert a bell glass over them. In a few hours, after having wandered around the sides of the jar many times, they bury themselves, and no further trouble is necessary than to set the jar in a moist, cool cellar, until the following spring. Larvæ of the same age, fed in the same cage, and in the same way, *will differ a week or ten days in coming to maturity*; but all may be placed in the same jar for the final change, care being taken to disturb the jar as little as possible while untying the netting or removing the bell glass, to put in the succeeding specimens. When your larvæ are all full fed, and have gone down in the jar, wet a thick piece of woodland moss, put it over the top of the jar, and set them, as above stated, in a cool, moist cellar, and they will be in good condition for "*planting*" in the spring.

This last operation is necessary, in order that your specimens may be perfectly expanded, and that they may be carefully watched during the season of the last metamorphosis, from the pupa to the imago. Fill a large jar nearly full of the same mellow loam; thrust the finger in this to the depth of an inch and a half or its whole length (according to the size of your pupa), and at an angle of about sixty degrees. In the hole made by the finger, put your chrysalid, *head uppermost*, and beside it a small, smooth stick, letting the latter project from the earth five or six inches. Having continued this operation until as many chrysalids are planted as the jar will accommodate, cover them over with the loam to the depth of an inch or more, set your jar and its contents in a breeding cage, sprinkle the surface occasionally with pure rain water, and in due season your imago will leave its pupa prison-house, ascend the little stick, dry and expand its wings, and you can then kill and mount it for your collection (by a process to be explained in a future paper), or use it for the further propagation of the species. If your larvæ are those of species which spin cocoons, no jar of earth, or removal from the vivarium will be necessary, as they spin their cocoons to the branches, and among the leaves of the food-plant, and may be left undisturbed until the following spring, in the same position, by placing the cage in a cool, moist cellar, or outhouse, *free of mice.* In the spring these will crawl out of the cocoons, clinging to the cocoon or the branch to which it is fastened, and when the wings are fully expanded, may be treated as before mentioned. In the way above described the writer has reared, from the eggs of a single female, *fifty-four imagos of the T. polyphemus*, being at liberty to observe all the moults, feeding habits, resting and sleeping habits, and other points of interest connected with their growth and development. It is well to remember, that young larvæ, just hatched, *often refuse the food-plant, unless confined.* In such cases put them in a glass bottle, with tender leaves of their food, *and cork the bottle.* They will soon commence feeding, and may, in a day or two, be removed to the cage. The cages should be kept out of the sun, and where there may, *at all times*, be a free circulation of air. These conditions may generally be found at the north side of houses, where the cage may be suspended to a nail driven in the wall.

The writer intends to follow this paper with others, giving notes of habit, time and place of collecting, food-plant and appearance of species, and such information as he hopes may be of use to those who wish to engage, practically, in the study of this most interesting and useful branch of natural history. It is a great pleasure to have fine, perfect specimens of any species for such study; but the pleasure is much greater when the student can say to his friend, that he has reared his specimen from the egg, observed its entire habits of life, and secured and preserved it himself, to be

"A thing of beauty, and a joy forever."

And this any earnest person can do, with a little careful observation and pleasurable labor, and with great mental profit. To stimulate a taste for such recreations, that give pure enjoyment without the possibility of evil consequences, is the chief object of this article.

New Equine Mammals, from the Tertiary Formation. By O. C. MARSH. From The Am. Jour. of Sci. and Arts, for March, 1874.

Prof. Marsh has described some new equine mammals from the Tertiary formation of the western territories, in the March number of the American Journal of Science and Arts, and thrown a great deal of light on the origin of the horse. He has described a genus under the name of *Orohippus*, from the Eocene of Wyoming and Utah, the skeleton of which, in its general features, is decidedly equine, but the animal was only about the size of a fox. Another, under the name of *Miohippus*, from the Miocene of Oregon, somewhat exceeding a sheep in size, and with longer limbs. And another, under the name of *Pliohippus*, from the Pliocene of the Niobrara River, about the size of the ass. He says in conclusion:

"The large number of equine mammals now known, from the Tertiary deposits of this country, and their regular distribution through the sub-divisions of this formation, afford a good opportunity to ascertain the probable lineal descent of the modern horse. The American representative of the latter is the extinct *Equus fraternis* (Leidy), a species almost, if not entirely, identical with the old world *Equus caballus* (Linn), to which our recent horse belongs. Huxley has traced successfully the latter genealogy of the horse through European extinct forms, but the line in America was probably a more direct one, and the record is more complete. Taking them as the extreme of a series *Orohippus agilis* (Marsh), from the Eocene, and *Equus fraternis* (Leidy), from the Quaternary, intermediate forms may be intercalated with considerable certainty, from the thirty or more well marked species that lived in the intervening periods. The natural line of descent would seem to be through the following genera: *Orohippus*, of the Eocene; *Miohippus* and *Anchitherium*, of the Miocene; *Anchippus Hipparion Protohippus* and *Pliohippus*, of the Pliocene; and *Equus*, Quaternary and recent.

The most marked changes undergone by the successive equine genera are as follows: 1st, increase in size; 2d, increase in speed, through concentration of limb bones; 3d, elongation of head and neck, and modifications of skull. The increase in size is remarkable. The Eocene *Orohippus* was about the size of a fox. *Miohippus* and *Anchitherium*, from the Miocene, were about as large as a sheep. *Hipparion* and *Pliohippus*, of the Pliocene, equaled the ass in height; while the size of the Quaternary *Equus* was fully up to that of the modern horse.

The increase of speed was equally marked, and was a direct result of the gradual modification of the limbs. The latter were slowly concentrated by the reduction of their lateral elements and enlargement of the axial one, until the force exerted by each limb came to act directly through its axis, in the line of motion. This concentration is well seen, *e. g.*, in the fore limb. There was, 1st, a change in the scapula and humerus, especially in the latter, which facilitated motion in one line only; 2d, an expansion of the radius and reduction of the ulna, until the former alone remained entire and effective; 3d, a shortening of all the carpal bones, and enlargement of the median ones, insuring a firmer wrist; 4th, an increase in size of the third digit, at the expense of those on each side, until the former alone supported the limb. The latter change is clearly shown in the following diagram (here omitted), which represents the fore feet of four typical genera in the equine series, taken in succession from each of the geological periods in which this group of mammals is known to have lived. The ancient Orohippus had all four digits of the manus well developed. In Miohippus, of the next period, the fifth toe has disappeared, or is only represented by a rudiment, and the limb is supported by the second, third, and fourth, the middle one being the largest. Hipparion, of the later Tertiary, still has three digits, but the third is much stouter, and the outer ones have ceased to be of use, as they do not touch the ground. In *Equus*, the last of the series, the lateral hoofs are gone, and the digits themselves are represented only by the rudimentary splint-bones (the modern horse occasionally has one of the ancestral hooflets developed usually on the fore foot). The middle or third digit supports the limb, and its size has increased accordingly. The corresponding changes in the posterior limb of these genera are very similar, but not so manifest as the oldest type (*Orohippus*), as the latter is by its Miocene relative. A still older ancestor, probably the cretaceous, doubtless had five toes in each foot, the typical number in mammals. This reduction in the number of toes may, perhaps, have been due to elevation of the region inhabited, which gradually led the animals to live on higher ground, instead of the soft lowlands, where a polydactyl foot would be an advantage.

The gradual elongation of the head and neck, which took place in the successive genera of this group during the Tertiary period, was a less fundamental change than that which resulted in the reduction of the limbs. The process may be said to have already began in *Orohippus*, if we compare that form with other most nearly allied mammals. The diastema, or "place for the bit," was well developed in both jaws even then, but increased materially in succeeding genera. The number of the teeth remained the same until the Pliocene, when the front lower premolar was lost and subsequently the corresponding upper tooth ceased to be functionally developed. The next upper premolar, which in *Orohippus* was the smallest of the six posterior teeth, rapidly increased in size and soon became, as in the horse, the largest of the series. The grinding teeth at first had very short crowns, without cement, and were inserted by distinct roots. In Pliocene species, the molars became longer and were more or less coated with cement. The canine teeth were very large in *Orohippus*, and in this genus, as well as those from the Middle Tertiary, appear to have been well developed in both sexes. In later forms these teeth declined in size, especially as the changes in the limbs afforded other facilities for defense, or escape from danger. The incisors in the early forms were small, and without the characteristic pit of the modern horse. In the genera from the American Eocene and Miocene the orbit was not inclosed behind by an entire bridge of bone, and this first makes its appearance in this country in Pliocene forms. The depression in front of the orbit, so characteristic of *Anchitherium* and some of the Pliocene genera, is, strange to say, not seen in *Orohippus*, or the later *Miohippus*, and is wanting likewise in exising horses. It is an interesting fact that the peculiarly equine features acquired by *Orohippus* are retained persistingly throughout the entire series of succeeding forms. Such, *e. g.*, is the form of symphysial part of the lower jaw, and also the characteristic astragalus, with its narrow, oblique, superior ridges, and its small articular facet for the cuboid.

Such is, in brief, a general outline of the more marked changes that seem to have produced in America the highly specialized modern *Equus* from his diminutive, four-toed predecessor, the Eocene *Orohippus*. The line of descent appears to have been direct, and the remains now known supply every important intermediate form. It is, of course, impossible to say with certainty through which of the three-toed genera of the Pliocene that lived together the succession came. It is not impossible that the later species which appear generically identical, are the descendants of more distinct Pliocene types, as the persistent tendency in all the earlier forms was in the same direction. Considering the remarkable development of the group throughout the entire Tertiary period, and its existence even later, it seems very strange that none of the species should have survived, and that we are indebted for our present horse to the old world.

Trichinæ spiralis.

The recent excitement in this vicinity about the *Trichinæ spiralis*, and especially at Aurora, Indiana, where several persons died from eating diseased pork, renders any information upon this subject extremely interesting, even though it may not be exactly new.

In volume ix., page 205, of the Journal of the Linnean Society, will be found the experiments with *Trichinæ spiralis*, by Cobbold. He gave human flesh containing *Trichinæ* to several dogs, a guinea pig, and a hedge hog, all of which died in a few days, and their muscles were found to contain living *Trichinæ*. A piece of the hedge hog was fed to a cat, and another piece to a dog, both of which died within a few days, presenting the same result. Several feedings of this flesh were administered to a pig, which was kept ten months and then destroyed. It was estimated to contain 16,000,000 living *Trichinæ* inclosed within perfectly formed capsules, none of which latter exhibited any traces of calcareous deposition. A piece of the human flesh was given to a dog, and in sixty-nine hours afterward the dog was killed, and sexually mature living *Trichinæ* were found developed in its flesh. The parasites were found in the tongue of a trichinized German subject, at the hospital, so closely agglomerated that the point of a needle could not be thrust between the capsules. If all his flesh had been infested to the same extent, it was estimated that he would have contained one hundred million living *Trichinæ*.

An ounce of the trichinized human muscle flesh was administered to a sheep, which was killed in two and a half months afterward, and no *Trichinæ* could be found in it. Two chickens were fed with the same material, and at their death no *Trichinæ* were observed. A crow was fed on the flesh of a trichinized terrier dog, and in a few months thereafter was killed, but no *trichinæ* were found in its flesh. Several feedings of the trichinized flesh from the guinea pig, to a sheep, to a chicken, and to a goose, failed to develop any *trichinæ* in these animals.

From his experiments he inferred that carniverous mammals, and especially those which subsist on a mixed diet, are most liable to entertain *trichinæ*, and that herbivorous animals are not likely to be so infested, though other experimenters had succeeded in rearing muscle *trichinæ* in a calf.

Some of the trichinized pork from Aurora was exhibited by Dr. Sutton, at the February meeting of the Cincinnati Society of Natural History. It appeared healthy to the naked eye, but under a microscope every part of it showed the parasites coiled, twisted, and amassed together.

Notice of the Appearance of the Rocks at Blue Lick Springs, in Nicholas county, Kentucky. (By G. W. Ransom.)

A peculiar appearance is presented in the pavement at the fountain at Lower Blue Lick Sprngs, in Nicholas county, Ky. At the junction of the flags, which are ordinary limestone, there is an elevation of half an inch, with a breadth of about the same extent; this occurs only at the joints of the stones. It is about twenty years since the pavement was laid, and at that time there was no inequality in the surface. What has caused this variation, so uniformly, at the same distance from the edges of the stones?

On the Phenomena of Variation and Geographical Distribution as illustrated by the Papilionidæ of the Malayan Region. By Alfred R. Wallace, Esq. [From the Transactions of the Linnean Society, vol. xxv., p. 1.]

When the naturalist studies the habits, the structure, or the affinities of animals, it matters little to which group he especially devotes himself; all alike offer him endless materials for observation and research. But, for the purpose of investigating the phenomena of geographical distribution, and of local or general variation, the several groups differ greatly in their value and importance. Some have too limited a range, others are not sufficiently varied in specific forms, while, what is of most importance, many groups have not received that amount of attention over the whole region they inhabit, which could furnish materials sufficiently approaching to completeness to enable us to arrive at any accurate conclusions as to the phenomena they present as a whole. It is in those groups which are and have long been favorites with collectors, that the student of distribution and variation will find his materials the most satisfactory, from their comparative completeness.

Preëminent among such groups are the diurnal Lepidoptera or butterflies, whose extreme beauty and endless diversity have led to their having been assiduously collected in all parts of the world, and to the numerous species and varieties having been figured in a series of magnificent works, from those of Cramer, the contemporary of Linnæus, down to the inimitable production of our own Hewitson. But, besides their abundance, their universal distribution, and the great attention that has been paid to them, these insects have other qualities that especially adapt them to elucidate the branches of inquiry already alluded to. These are the immense development and peculiar structure of the wings, which not only vary in form more than those of any other insects, but offer on both surfaces an endless variety of pattern, coloring, and texture. The scales with which they are more or less completely covered, imitate the rich hues and delicate surfaces of satin or of velvet, glitter with metallic lustre, or grow with the changeable tints of the opal. This delicately painted surface acts as a register of the minutest differences of organization—a shade of color, an additional streak or spot, a slight modification of outline continually recurring with the greatest regularity and fixity, while the body and all its other members exhibit no appreciable change. The wings of butterflies, as Mr. Bates has well put it, "serve as a tablet on which Nature writes the story of the modifications of species;" they enable us to perceive changes that would otherwise be uncertain and difficult of observation, and exhibit to us on an enlarged scale the effects of the climatal and other physical conditions which influence, more or less profoundly, the organization of every living thing.

A proof that this greater sensibility to modifying causes is not imaginary, may, I think, be drawn from the consideration that while the Lepidoptera as a whole are of all insects the least essentially varied in form, structure, or habits, yet in the number of their specific forms they are not much inferior to those orders which range over a much wider field of nature, and exhibit more deeply seated structural modifications. The Lepidoptera are all vegetable feeders in their larvæ state, and suckers of juices or other liquids in their perfect form. In their most widely separated groups they differ but little from a common type, and offer comparatively unimportant modifications of structure or of habits. The Coleoptera, the Diptera, or the Hymenoptera, on the other hand, present far greater and more essential variations. In either of these orders we have both vegetable and animal feeders, aquatic, and terrestrial, and parasitic groups. Whole families are devoted to special departments in the economy of nature. Seeds, fruits, bones, carcasses, excrement, bark, have each their special and dependent insect tribes from among them; whereas the Lepidoptera are, with but few exceptions, confined to the one function of devouring the foliage of living vegetation. We might, therefore, anticipate that their population would be only equal to those of the sections of the other orders that have a similar uniform mode of existence; and the fact that their numbers are at all comparable with those of entire orders, so much more varied in organization and habits, is, I think, a proof that they are in general highly susceptible of specific modification.

The Papilionidæ are a family of diurnal Lepidoptera which have hitherto, by almost universal consent, held the first rank in the order; and though this position has recently been denied them, I can not altogether acquiesce in the reasoning by which it has been proposed to degrade them to a lower rank. In Mr. Bates' most excellent paper on the Heliconidæ, he claims for that family the highest position, chiefly because of the imperfect structure of the fore legs, which is there carried to an extreme degree of abortion, and thus removes them further than any other family from the Hesperidæ and Heterocera, which all have perfect legs. Now it is a question whether any amount of difference which is exhibited merely in the imperfection or abortion of certain organs, can establish in the group exhibiting it a claim to a high grade of organization; still less can this be allowed when another group, along with perfection of structure in the same organs, exhibits modifications peculiar to it, together with the possession of an organ which in the remainder of the order is altogether wanting. This is, however, the position of the Papilionidæ. The perfect insect possess two characters quite peculiar to them. Mr. Edward Doubleday, in his "Genera of Diurnal Lepidoptera," says: "The Papilionidæ may be known by the apparently four-branched median nervule and the spur on the anterior tibiæ, characters found in no other family." The four-branched median nervule is a character so constant, so peculiar, and so well marked, as to enable a person to tell, at a glance at the wings only of a butterfly, whether it does or does not belong to this family; and I am not aware that any other group of butterflies, at all comparable to this in extent and modifications of form, possesses a character in its neuration to which the same degree of certainty can be attached. The spur on the anterior tibiæ is also found in some of the Hesperidæ, and is, therefore, supposed to show a direct affinity between the two groups; but I do not imagine it can counterbalance the differences in neuration and in every other part of their organization. The most characteristic feature of the Papilionidæ, however, and that on which I think insufficient stress has been laid, is undoubtedly the peculiar structure of the larvæ. These all possess an extraordinary organ situated on the neck, the well known Y-shaped tentacle, which is entirely concealed in a state of repose, but which is capable of being suddenly thrown out by the insect when alarmed. When we consider this singular apparatus, which in some species is nearly half an inch long, the arrangement of muscles for its protrusion and retraction, its perfect concealment during repose, its blood-red color, and the suddenness with which it can be thrown out, we must, I think, be led to the conclusion that it serves as a protection to the larvæ, by startling and frightening away some enemy when about to seize it, and is thus one of the causes which has led to the wide extension and maintained the permanence of this now dominant group. Those who believe that such peculiar structures can only have arisen by very minute successive variations, each one advantageous to its possessor, must see, in the possession of such an organ by one group, and its complete absence in every other, a proof of a very ancient origin, and of a very long continued modification. And such a positive structural addition to the organization of the family, subserving an important function, seems to me alone sufficient to warrant us in considering the Papilionidæ as the most highly developed portion of the whole order, and thus in retaining it in the position which the size, strength, beauty, and general structure of the perfect insects have been generally thought to deserve.

The Papilionidæ are pretty widely distributed over the earth, but are especially abundant in the tropics, where they attain their maximum of size and beauty, and the greatest variety of form and coloring. South America, North India, and the Malay Islands are the regions where these fine insects occur in the greatest profusion, and where they actually become a not unimportant feature in the scenery. In the Malay Islands in particular the giant Ornithopteræ may be frequently seen about the borders of the cultivated and forest districts, their large size, stately flight, and georgeous coloring rendering them even more conspicuous than the generality of birds. In the shady suburbs of the town of Malacca two large and handsome Papilios (*Memnon* and *Nephelus*) are not uncommon, flapping with irregular flight along the roadway, or, in the early morning, expanding their wings to the invigorating rays of the sun. In Amboyna and other towns of the Moluccas, the magnificent *Deiphobus* and *Severus*, and occasionaly even the azure-winged *Ulysses*, frequent similar situations, fluttering about the orange-trees and flower-beds, or sometimes even straying into the narrow bazaars or covered markets of the city. In Java the golden dusted *Arjuna* may often be seen at damp places on the roadside in the mountain districts, in company with *Sarpedon*, *Bathycles*, and *Agamemnon*, and less frequently the beautiful swallow-tailed *Antiphates*. In the more luxuriant parts of these islands one can hardly take a morning's walk in the neighborhood of a town or village without seeing three or four species of *Papilio*, and often twice that number. No less than 120 species of the family are now known to inhabit the Archipelago, and of these ninety-six were collected by myself. Twenty-nine species are found in Borneo, being the largest number in any one island, twenty-three species having been obtained by myself in the Vicinity of Sarawak; Java has twenty-seven species; Celebes and the Peninsula of Malacca, twenty-three each. Further east the numbers decrease, Batchian producing seventeen, and New Guinea only thirteen, though this number is certainly too small, owing to our present imperfect knowledge of that great island.

In estimating these numbers I have had the usual difficulty to encounter, of determining what to consider species and what varieties. The Malayan region, consisting of a large number of islands of generally great antiquity, possesses, compared to its actual area, a great number of distinct forms, often indeed distinguished by very slight characters, but in most cases so constant in large series of specimens, and so easily separable from each other, that I know not on what principle we can refuse to give them the name and rank of species. One of the best and most orthodox definitions is that of Pritchard, the great ethnologist, who says, that "*separate origin and distinctness of race, evinced by a constant transmission of some characteristic peculiarity of organization*," constitutes a species. Now leaving out the question of "origin," which we can not determine, and taking only the proof of separate origin, "*the constant transmission of some characteristic peculiarity of organization*," we have a definition which will compel us to neglect altogether the *amount* of difference between any two forms, and to consider only whether the differences that present themselves are *permanent*. The rule, therefore, I have endeavored to adopt is, that when the difference between two forms inhabiting separate areas seems quite constant, when it can be defined in words, and when it is not confined to a single peculiarity only, I have considered such forms to be species. When, however, the individuals of each locality vary among themselves, so as to cause the distinctions between the two forms to become inconsiderable and indefinite, or where the differences, though constant, are confined to one particular only, such as size, tint, or a single point of difference in marking or in outline, I class one of the forms as a variety of the other.

I find as a general rule that the constancy of species is in an inverse ratio to their range. Those which are confined to one or two islands are generally very constant. When they extend to many islands, considerable variability appears; and when they have an extensive range over a large part of the archipelago, the amount of unstable variation is very large. These facts are explicable on Mr. Darwin's principles. When a species exists over a wide area, it must have had, and probably still possesses, great powers of dispersion. Under the different conditions of existence in various portions of its area, different variations from the type would be selected, and, were they completely isolated, would soon become distinctly modified forms; but this process is checked by the dispersive powers of the whole species which leads to the more or less frequent intermixture of the incipient variety, which thus become irregular and unstable. Where, however, a species has a limited range, it indicates less active powers of dispersion, and the process of modification under changed conditions is less interfered with. The species will, therefore, exist under one or more permanent forms, according as portions of it have been isolated at a more or less remote period.

What is commonly called variation consists of several distinct phenomena, which have been too often confounded. I shall proceed to consider these under the heads of—1st, simple variability; 2d, polymorphism; 3d, local forms; 4th, co-existing varieties; 5th, races or subspecies; and 6th, true species.

1. *Simple variability.*—Under this head I include all those cases in which the specific form is to some extent unstable. Throughout the whole range of the species, and even in the progeny of individuals, there occur continual and uncertain differences of form, analogous to that variability which is so characteristic of domestic breeds. It is impossible usefully to define any of these forms, because they are indefinite gradations to each other form. Species which possess these characteristics have always a wide range, and are more frequently the inhabitants of continents than of islands, though such cases are always exceptional, it being far more common for specific forms to be fixed within very narrow limits of variation. The only good example of this kind of variability which occurs among the Malayan Papilionidæ is in *Papilio Severus*, a species inhabiting all the islands of the Moluccas and

New Guinea, and exhibiting in each of them a greater amount of individual difference than often serves to distinguish well-marked species. Almost equally remarkable are the variations exhibited in most of the species of *Ornithoptera*, which I have found in some cases to extend even to the form of the wing and the arrangement of the nervures. Closely allied, however, to these variable species are others, which, though differing slightly from them, are constant and confined to limited areas. After satisfying oneself, by the examination of numerous specimens captured in their native countries, that the one set of individuals are variable, and the others are not, it becomes evident that by classing all alike as varieties of one species we shall be obscuring an important fact in nature, and that the only way to exhibit that fact in its true life is to treat the invariable local form as a distinct species, even though it does not offer better distinguishing characters than do the extreme forms of the variable species. Cases of this kind are the *Ornithoptera Priamus*, which is confined to the islands of Ceram and Amboyna, and is very constant in both sexes, while the allied species inhabiting New Guinea and the Papuan Islands is exceedingly variable; and in the island of Celebes is a species closely allied to the variable *P. Severus*, but which, being exceedingly constant, I have described as a distinct species under the name of *Papilio Pertinax*.

2. *Polymorphism or Dimorphism.*—By this term I understand the co-existence in the same locality of two or more distinct forms not connected by intermediate gradations, and all of which are occasionally produced from common parents. These distinct forms generally occur in the female sex only, and the intercrossing of two of these forms does not generate an intermediate race, but reproduces the same forms in varying proportions. I believe it will be found that a considerable number of what have been classed as *varieties* are really cases of *polymorphism*. Albinoism and melanism are of this character, as well as most of these cases in which well-marked varieties occur in company with the parent species, but without any intermediate forms. Under these circumstances, if the two forms breed separately, and are never reproduced from a common parent, they must be considered as distinct species, contact without intermixture being a good test of specific difference. On the other hand, intercrossing without producing an intermediate race is a test of dimorphism. I consider, therefore, that under any circumstances the term, "variety," is wrongly applied to such cases.

The Malayan Papilionidæ exhibit some very curious instances of polymorphism, some of which have been recorded as varieties, others as distinct species; and they all occur in the female sex. *Papilio*

Memon, L., is one of the most striking, as it exhibits the mixture of simple variability, local and polymorphic forms, all hitherto classed under the common title of varieties. The polymorphism is strikingly exhibited by the females, one set of which resemble the males in form, with a variable paler coloring; the others have a large spatulate tail to the hinder wing, and a distinct style of coloring, which causes them closely to resemble *P. Coon*, a species of which the sexes are alike and inhabiting the same countries, but with which they have no direct affinity. The tailless females exhibit simple variability, scarcely two being found exactly alike even in the same locality. The males of the island of Borneo exhibit constant differences of the under surface, and may therefore be distinguished as a local form, while the continental specimens, as a whole, offer such large and constant differences from those of the islands that I am inclined to separate them as a distinct species—*P. Androgeus*, Cr. We have here, therefore, distinct species, local forms, polymorphism, and simple variability, which seem to me to be distinct phenomena, but which have been hitherto all classed together as varieties. I may mention that the fact of these distinct forms being one species is doubly proved. The males, the tailed and tailless females, have all been bred from a single group of the larvæ, by Messrs. Payen and Bocarmé, in Java, and I myself captured in Sumatra a male *P. Memnon*, L., and a tailed female *P. Achates*, Cr., "in copulâ."

Papilio Pammon, L., offers a somewhat similar case. The female was described by Linnæus as *P. Polytes*, and was considered to be a distinct species till Westermann bred the two from the same larvæ (see Boisduval, "Species Générales des Lépidoptères," p. 272). They were therefore classed as sexes of one species by Mr. Edward Doubleday, in his "Genera of Diurnal Lepidoptera," in 1846. Later, female specimens were received from India closely resembling the male insect, and this was held to overthrow the authority of M. Westermann's observation, and to re-establish *P. Polytes* as a distinct species; and as such it accordingly appears in the British Museum List of Papilionidæ in 1856, and in the Catalogue of the East India Museum in 1857. This discrepancy is explained by the fact of *P. Pammon* having two females, one closely resembling the male, while the other is totally different from it. A long familiarity with this insect (which replaced by local forms or by closely allied species, occurs in every island of the archipelago) has convinced me of the correctness of this statement; for in every place where a male allied to *P. Pammon* is found, a female resembling *P. Polytes* also occurs, and sometimes, though less frequently than on the continent, another female closely resembling the male; while not only has no male specimen of *P. Polytes* yet been found, but the female (*Polytes*) has never yet been found in localities to which the male (*Pammon*) does not extend. In this case, as in the last, distinct species, local forms, and dimorphic specimens have been confounded under the common appelation of varieties.

But, beside the true *B. Polytes*, there are several allied forms of females to be considered, namely, *P. Theseus*, Cr., *P. Melanides*, De Haan, *P. Elyros*, G. R. G., and *P. Romulus*, L. The dark female figured by Cramer as *P. Theseus* seems to be the common and perhaps the only form in Sumatra, whereas in Java, Borneo and Timor, along with males quite identical with those of Sumatra, occur females of the *Polytes* form, although a single specimen of the true *P. Theseus*, C. R., taken at Lombock, would seem to show that the two forms do occur together. In the allied species found in the Philippine Islands (*P. Alphenor*, Cr., *P. Ledebouria*, Eschsch., *P. Elyros*, G. R. G.), forms corresponding to these extremes occur along with a number of intermediate varieties, as shown by a fine series in the British Museum. We have here an indication of how dimorphism may be produced; for let the extreme Philippine forms be better suited to their conditions of existence than the intermediate connecting links, and the latter will gradually die out, leaving two distinct forms of the same insect, each adapted to some special conditions. As these conditions are sure to vary in different districts, it will often happen, as in Sumatra and Java, that the one form will predominate in the one island, the other in the adjacent one. In the island of Borneo there seems to be a third form; for *P. Melanides*, De Haan, evidently belongs to this group, and has all the chief characteristics of *T. Theseus*, with a modified coloration of the hind wings. I now come to an insect which, if I am correct, offers one of the most interesting cases of variation yet adduced. *Papilio Romulus*, L., a butterfly found over a large part of India and Ceylon, and not uncommon in collections, has always been considered a true and independent species, and no suspicions have been expressed regarding it. But a male of this form does not, I believe, exist. I have examined the fine series in the British Museum, in the East India Company's Museum, in the Hope Museum at Oxford, in Mr. Hewitson's and several other private collections, and can find nothing but females; and for this common butterfly no male partner can be found except the equally common *P. Pammon*, a species already provided with two wives, and yet to whom we shall be forced, I believe, to assign a third. On carefully examining *P. Romulus*, I find that in all essential characters—the form and texture of the wings, the length of the antennæ, the spotting of the head and thorax, and even the peculiar tints and shades with which it is ornamented—it corresponds exactly with the other females of the *Pammon* group; and though, from the peculiar marking of the fore wings, it has at first sight a very different aspect, yet a closer examination shows that every one of its markings could be produced by slight and almost imperceptible modifications of the various allied forms. I fully believe, therefore, that I shall be correct in placing *P. Romulus*, as a third Indian form of the female *P. Pammon*, corresponding to *P. Melanides*, the third form of the Malayan *P. Theseus*. I may mention here that the females of this group have a superficial resemblance to the *Polydorus* group, as shown by *P. Theseus* having been considered to be the female of *P. Antiphus*, and by *P. Romulus* being arranged next to *P. Hector*. There is no close affinity between these two groups of *Papilio*, and I am disposed to believe that we have here a case of mimicry, brought about by the same causes which Mr. Bates has so well explained in his account of Heliconidæ, and which thus led to the singular exuberance of polymorphic forms in this and allied groups of the genus *Papilio*. I shall have to devote a section of my paper to the consideration of this subject.

The third example of polymorphism I have to bring forward is *Papilio Ormenus*, Guér., which is closely allied to the well known *P. Erechtheus*, Don., of Australia. The most common form of the female also resembles that of *P. Erechtheus*; but a totally different looking insect was found by myself in the Aru Islands, and figured by Mr. Hewitson under the name of *P. Onesimus*, which subsequent observation has convinced me is a second form of the female of *P. Ormenus*. Comparison of this with Boisduval's description of *P. Amanga*, a specimen of which from New Guinea is in the Paris Museum, shows the latter to be a closely similar form; and two other specimens were obtained by myself, one in the island of Goram, and the other in Waigiou, all evidently local modifications of the same form. In each of these localities males and ordinary females of *P. Ormenus* were also found. So far there is no evidence that these light-colored insects are not females of a distinct species, the males of which have not been discovered. But two facts have convinced me that this is not the case. At Dorey, in New Guinea, where males and ordinary females closely allied to *P. Ormenus* occur (but which seem to me worthy of being separated as a distinct species), I found one of these light-colored females closely followed in her flight by three males, exactly in the same manner as occurs (and, I believe, occurs only) with the sexes of the same species. After watching them a considerable time, I captured the whole of them, and became satisfied that I had discovered the true relations of this anomalous form. The next year I had corroborative proof of the correctness of this opinion by the discovery in the island of Batchian of a new species allied to *P. Ormenus*, all the females of which, either seen or captured by me, were of one form, and much more closely resembling the abnormal light-colored females of *P. Ormenus* and *P. Pandion*, than the ordinary specimens of that sex. Every naturalist will, I think, agree that this is strongly confirmative of the supposition that both forms of female are of one species; and when we consider, further, that in four separate islands, in each of which I resided for several months, the two forms of female were obtained, and only one form of male ever seen, and that about the same time M. Montrouzier in Woodlark Island, at the other extremity of New Guinea (where he resided several years, and must have obtained all the large Lepidoptera of the island), obtained females closely resembling mine, which, in despair at finding no appropriate partners, for them he mates with a widely different species, it becomes, I think, sufficiently evident that this is another case of polymorphism of the same nature as those already pointed out in *P. Pammon* and *P. Memnon*. This species, however, is not only *dimorphic*, but *trimorphic*; for, in the island of Waigiou, I obtained a third female quite distinct from either of the others, and in some degree intermediate between the ordinary female and the male. The specimen is particularly interesting to those who believe, with Mr. Darwin, that extreme difference of the sexes has been gradually produced by what he terms sexual selection, since it may be supposed to exhibit one of the intermediate steps in that process which has been accidentally preserved in company with its more favored rivals, though its extreme rarity (only one specimen having been seen to many hundreds of the other form) would indicate that it may soon become extinct.

The only other case of polymorphism in the genus *Papilio*, at all equal in interest to those I have now brought forward, occurs in America; and we have, fortunately, accurate information about it. *Papilio Turnus*, L., is common over almost the whole of temperate North America; and the female resembles the male very closely. A totally different looking insect, both in form and color, *Papilio Glaucus*, L., inhabits the same region; and though down to the time when Boisduval published his "Species Général," no connection was supposed to exist between the two species, it is now well asceratined that *P. Glaucus* is a second female form of *P. Turnus*. In the "Proceedings of Entomological Society of Philadelphia," Jan., 1863, Mr. Walsh gives a very interesting account of the distribution of this species. He tells us that in the New England States, and in New York, all the females are yellow, while in Illinois and further south all are black; in the intermediate region both black and yellow females occur in varying proportions. Lat. 37° is approximately the southern limit of the yellow form, and 42° the northern limit of the black form; and, to render the proof complete, both black and yellow insects have been bred from a single batch of eggs. He further states, that out of thousands of specimens he has never seen or heard of intermediate varieties between these forms. In this interesting example we see the effects of latitude in determining the proportions in which the individuals of each form should exist. The conditions are *here* favorable to the one form, *there* to the other; but we are by no means to suppose that these conditions consist in climate alone. It is highly probable that the existence of enemies, and of competing forms of life, may be the main determining influences; and it is much to be wished, that such a competent observer as Mr. Walsh would endeavour to ascertain what are the adverse causes which are most efficient in keeping down the numbers of each of these contrasted forms.

Dimorphism of this kind in the animal kingdom does not seem to have any direct relations to the reproductive powers, as Mr. Darwin has shown to be the case in plants, nor does it appear to be very general. One other case only is known to me in another family of my eastern Lepidoptera, the *Pieridæ*; and but few occur in the Lepidoptera of other countries. The spring and autumn broods of some European species differ very remarkably; and this must be considered as a phenomenon of an analogous though not of an identical nature. *Araschnia prorsa*, Central Europe, is a striking example of this alternate or seasonal dipmorphism. Mr. Pascoe has pointed out two forms of the male sex in some species of Coleoptera belonging to the family Anthribidæ, in seven species of the two genera *Xenocerus* and *Mecocerus* (Proc. Ent. Soc. Lond., 1862, p. 71); and no less than six European Water-beetles, of the genus *Dytiscus*, have females of two forms, the most common having the elytra deeply sulcate, the rarer smooth as in the males. The three, and sometimes four or more, forms under which many Hymenopterous insects (especially ants) occur, must be considered as a related phenomenon, though here each form is specialized to a distinct function in the economy of the species. Among the higher animals, albinoism may, as I have already stated, be considered as analogous facts, and I met with one case of a bird, a species of Lory (*Eos fuscata*, Blyth), clearly existing under two forms, since I obtained both sexes of each from a single flock.

The fact of the two sexes of one species differing very considerably is so common, that it attracted but little attention till Mr. Darwin showed how it could in many cases be explained by what he termed sexual selection. For instance, in most polygamous animals the males fight for the possession of the females, and the victors, always becoming the progenitors of the succeeding generation, impress upon their male offspring their own superior size, strength, or unusally developed offensive weapons. It is thus that we can account for the spurs and the superior strength and size of the males in gallinaceous birds, and also for the large canine tusks in the males of the fruit-eating Apes. So the superior beauty of plumage and special adornments of the males of so many birds can be explained by supposing (what there are many facts to prove) that the females prefer the most beauty of plumage and perfect-plumaged males, and that thus slight accidental variations of form and colour have been accumulated till they have produced the wonderful train of the peacock, and the gorgeous plumage of the bird of paradise. Both these causes have no doubt acted partially in insects, so many species possessing horns and powerful jaws in the male sex only, and still more frequently the males alone rejoicing in rich colors or sparkling lustre. But there is here another cause which has led to sexual differences, viz., a special adaptation of the sexes to diverse habits or modern life. This is well seen in female butterflies (which are generally weaker and of slower flight), often having colors better adapted to concealment; and in certain South American species (*Papilo torquatus*) the females, which inhabit the forest, resemble the *Æneas* group, which abound in similar localities, while the males, which frequent the sunny, open river-banks, have a totally different coloration. In these cases, therefore, natural selection seems to have acted independently of sexual selection; and all such cases may be considered as examples of the simplest dimorphism, since the offspring never offer intermediate varieties between the parent forms.

The distinctive character therefore of dimorphism is this, that the union of these distinct forms does not produce intermediate varieties, but reproduces them unchanged. In simple varieties, on the other hand, as well as when distinct local forms or distinct species are crossed, the offspring never resembles either parent exactly, but is more or less intermediate between them. Dimorphism is thus seen to be a specialized result of variations, by which new physiological phenomena have been developed; the two should therefore, whenever possible, be kept separate.*

* The phenomena of *dimorphism* and *polymorphism* may be well illustrated by supposing that a blue-eyed, flaxen-haired Saxon man had two wives, one a black-haired, red-skinned Indian squaw, the other a wooly-headed, sooty-skinned negress—and that instead of the children being mulattoes of brown or dusky tints, mingling the separate characteristics of their parents in varying degrees, all the boys should be pure Saxon boys like their father, while the girls should altogether resemble their mothers. This would be thought a sufficiently wonderful

3. *Local form, or variety.*—This is the first step in the transition from variety to species. It occurs in species of wide range, when groups of individuals have become partially isolated in several points of its area of distribution, in each of which a characteristic form has become segregated more or less completely. Such forms are very common in all parts of the world, and have often been classed as varieties or species alternately. I restrict the term to those cases where the difference of the forms is very slight, or where the segregation is more or less imperfect. The best example in the present group is *Papilio Agamemnon*, L., a species which ranges over the greater part of tropical Asia, the whole of the Malay archipelago, and a portion of the Australian and Pacific regions. The modifications are principally of size and form, and, though slight, are tolerably constant in each locality. The steps, however, are so numerous and gradual that it would be impossible to define many of them, though the extreme forms are sufficiently distinct. *Papilio Sarpedon*, L., presents somewhat similar but less numerous variations.

4. *Co-existing variety.*—This is a somewhat doubtful case. It is when a slight but permanent and hereditary modification of form exists in company with the parent or typical form, without presenting those intermediate gradations which would constitute it a case of simple variability. It is evidently only by direct evidence of the two forms breeding separately that this can be distinguished from *dimorphism.* The difficulty occurs in *Papilio Jason*, Esp., and *P. Evemon*, Bd., which inhabit the same localities, and are almost exactly alike in form, size, and coloration, except that the latter always wants a very conspicuous red spot on the under surface, which is found not only in *P. Jason*, but in all the allied species. It is only by breeding the two insects that it can be determined whether this is a case of a co-existing variety or of *dimorphism.* In the former case, however, the difference being constant and so very conspicuous and easily defined, I see not how we could escape considering it as a distinct species. A true case of co-existing forms would, I consider, be produced, if a slight variety had become fixed as a local form, and afterward been brought into contact with the parent species with little or no intermixture of the two; and such instances do very probably occur.

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fact; yet the phenomena here brought forward as existing in the insect world are still more extraordinary; for each mother is capable not only of producing male offspring like the father, and female like herself, but also of producing other females exactly like her fellow-wife, and altogether differing from herself. If an island could be stocked with a colony of human beings having similar physiological idiosyncrasies with *Papilio Pammon* or *Papilio Ormenus*, we should see white men living with yellow, red and black women, and their offspring always reproducing the same types; so that at the end of many generations the men would remain pure white, and the women of the same well-marked races as at the commencement.

5. *Race, or subspecies.*—These are local forms completely fixed and isolated; and there is no possible test but individual opinion to determine which of them shall be considered as species, and which varieties. If stability of form and "*the constant transmission of some characteristic peculiarity of organization*" is the test of a species (and I can find no other test that is more certain than individual opinion), then every one of these fixed races, confined as they almost always are to distinct and limited areas, must be regarded as a species; and as such I have in most cases treated them. The various modifications of *Papilio Ulysses*, *P. Peranthus*, *P. Codrus*, *P. Eurypilus*, *P. Helenus*. etc., are excellent examples; for while some present great and well-marked. others offer slight and inconspicuous differences, yet in all cases these differences seem equally fixed and permanent. If, therefore, we call some of these forms species, and others varieties, we introduce a purely arbitrary distinction, and shall never be able to decide where to draw the line. The races of *Papilio Ulysses*, L., for example, vary in amount of modification from the scarcely differing New Guinea form to those of Woodlark Island and New Caledonia, but all seem equally constant; and as most of these had already been named and described as species, I have added the New Guinea form under the name of *P. Penelope*. We thus got a little group of Ulyssine Papilios, the whole comprised within a very limited area, each one confined to a separate portion of that area, and, though differing in various amounts, each apparently constant. Few naturalists will doubt that all these may and probably have been derived from a common stock; and therefore it seems desirable that there should be a unity in our method of treating them: either call them all *varieties* or all *species*. Varieties, however, continually get overlooked; in lists of species they are often altogether unrecorded; and thus we are in danger of neglecting the interesting phenomena of variation and distribution which they present. I think it advisable, therefore, to name all such forms; and those who will not accept them as species may consider them as sub-species or races.

6. *Species.*—Species are merely those strongly marked races or local forms which, when in contact, do not intermix, and when inhabiting distinct areas are generally believed to have had a separate origin, and to be incapable of producing a fertile hybrid offspring. But as the test of hybridity can not be applied in one case in ten thousand, and even if it could be applied, would prove nothing, since it is founded on an assumption of the very question to be decided—and as the test of separate origin is in every case inapplicable—and as, further, the test of non-intermixture is useless, except in those rare cases where

the most closely allied species are found inhabiting the same area, it will be evident that we have no means whatever of distinguishing so-called "true species" from the several modes of variation here pointed out, and into which they so often pass by an insensible gradation. It is quite true that, in the great majority of cases, what we term "species" are so well marked and definite that there is no difference of opinion about them; but as the test of a true theory is, that it accounts for, or at the very least if not inconsistent with, the whole of the phenomena and apparent anomalies of the problem to be solved, it is reasonable to ask that those who deny the origin of species by variation and selection should grapple with the facts in detail, and show how the doctrine of the distinct origin and permanence of species will explain and harmonize them. It has been recently asserted by a high authority that the difficulty of limiting species is in proportion to our ignorance, and that just as groups or countries are more accurately known and studied in greater detail the limits of species become settled. This statement has, like many other general assertions, its portion of both truth and error. There is no doubt that many uncertain species, founded on few or isolated specimens, have had their true nature determined by the study of a good series of examples: they have been thereby established as species or as varieties; and the number of times this has occurred is doubtless very great. But there are other and equally trustworthy cases in which, not single species, but whole groups have, by the study of a vast accumulation of materials, been proved to have no definite specific limits. A few of these must be adduced. In Dr. Carpenter's "Introduction to the Study of the Foraminifera," he states that "there is not a single specimen of plant or animal of which the range of variation has been studied by the collocation and comparison of so large a number of specimens as have passed under the review of Messrs. Williamson, Parker, Rupert Jones, and myself, in our studies of the types of this group;" and the result of this extended comparison of specimens is stated to be, "The range of variation is so great among the Foraminifera as to include not merely those differential characters which have been usually accounted SPECIFIC, but also those upon which the greater part of the GENERA of this group have been founded, and even in some instances those of its ORDERS" (Foraminifera, Preface, x.) Yet this same group has been divided by D'Orbigny and other authors into a number of clearly defined *families*, *genera*, and *species*, which these careful and conscientious researches have shown to have been almost all founded on incomplete knowledge.

Professor DeCandolle has recently given the results of an extensive review of the species of *Cupuliferæ*. He finds that the best known species of oaks are those which produce the most varieties and subvarieties, that they are often surrounded by a provisional species; and, with the fullest materials at his command, two thirds of the species he considers more or less doubtful. His general conclusion is, that "*in botany the lowest series of groups*, SUBVARIETIES, VARIETIES, *and* RACES, *are very badly limited; these can be grouped into* SPECIES *a little less vaguely limited, which again can be formed into sufficiently precise* GENERA." This general conclusion is entirely objected to by the writer of the article in the "Natural History Review," who, however, does not deny its applicability to the particular order under discussion, while this very difference of opinion is another proof that difficulties in the determination of species do not, any more than in higher groups, vanish with increasing materials and more accurate research.

Another striking example of the same kind is seen in the genera *Rubus* and *Rosa*, adduced by Mr. Darwin himself: for though the amplest materials exist for a knowledge of these groups, and the most careful research has been bestowed upon them, yet the various species have not thereby been accurately limited and defined so as to satisfy the majority of botanists.

Dr. Hooker seems to have found the same thing in his study of the Arctic flora. For though he has had much of the accumulated materials of his predecessors to work upon, he continually expresses himself as unable to do more than group the numerous and apparently fluctuating forms into more or less imperfectly defined species.

Lastly, I will adduce Mr. Bates' researches on the Amazons. During eleven years he accumulated vast materials, and carefully studied the variation and distribution of insects. Yet he has shown that many species of Lepidoptera, which before offered no special difficulties, are in reality most intricately combined in a tangled web of affinities, leading by such gradual steps from the slightest and least stable variations to fixed races and well marked species, that it is very often impossible to draw those sharp dividing lines which it is supposed that a careful study and full materials will always enable us to do.

These few examples show, I think, that in every department of nature there occur instances of the instability of specific form, which the increase of materials aggravates rather than diminishes. And it must be remembered that the naturalist is rarely likely to err on the side of imputing greater indefiniteness to species than really exists. There is a completeness and satisfaction to the mind in defining and limiting and naming a species, which leads us all to do so whenever we conscientiously can, and which we know has led many collectors to reject vague intermediate forms as destroying the symmetry of their cabinets. We must therefore consider these cases of excessive variation and instability as being thoroughly well established; and to the objection that, after all, these cases are but few compared with those in which species can be limited and defined, and are therefore merely exceptions to a general rule, I reply that a true law embraces all apparent exceptions, and that to the great laws of nature there are no real exceptions—that what appear to be such are equally results of law, and are often (perhaps, indeed, always) those very results which are most important as revealing the true nature and action of the law. It is for such reasons that naturalists now look upon the study of *varieties* as more important than that of well fixed species. It is in the former that we see nature still at work, in the very act of producing those wonderful modifications of form, that endless variety of color, and that complicated harmony of relations, which gratify every sense, and give occupation to every faculty of the true lover of nature.

Variation as specially influenced by Locality.

The phenomena of variation as influenced by locality have not hitherto received much attention. Botanists, it is true, are acquainted with the influences of climate, altitude, and other physical conditions, in modifying the forms and external characteristics of plants; but I am not aware that any peculiar influence has been traced to locality, independent of climate. Almost the only case I can find recorded is mentioned in that repertory of natural history facts, "The Origin of Species," viz.: that herbaceous groups have a tendency to become arboreal in islands. In the animal world, I can not find that any facts have been pointed out as showing the special influence of locality in giving a peculiar *facies* to the several disconnected species that inhabit it. What I have to adduce on this matter will therefore, I hope, possess some interest and novelty.

On examining the closely allied species, local forms, and varieties distributed over the Indian and Malayan regions, I find that larger or smaller districts, or even single islands, give a special character to the majority of their Papilionidæ. For instance: 1. The species of the Indian region (Sumatra, Java, and Borneo) are almost invariably smaller than the allied species inhabiting Celebes and the Moluccas. 2. The species of New Guinea and Australia are also, though in a less degree, smaller than the nearest species or varieties of the Moluccas. 3. In the Moluccas themselves the species of Amboyna are the largest. 4. The species of Celebes equal or even surpass in size those of Amboyna. 5. The species and varieties of Celebes possess a striking character in the form of the anterior wings, different from that of the allied species and varieties of all the surrounding islands. 6. Tailed species in India or the Indian region become tailless as they spread eastward through the archipelago.

From Ancient Mining on the Shores of Lake Superior. By CHARLES WHITTLESEY.

By whom were the ancient mines wrought? I have already given reasons going to show that it was not the present Indian race by whom these mines were worked.

As yet no remains of cities, graves, domicils, or highways have been found in the copper region. As the race appears to have been farther advanced in civilization than their successors, whom we call the aborigines, they probably had better means of transportation than the bark canoe. They might thus carry provisions a great distance by water. Their mine works are open cuts exposed to the day, which in the winter in this country, where snow lies from three to five feet in depth, could not be occupied comfortably without shelter. No remains of such coverings have been discovered, nor is it probable that any traces of such should now be recoverable. On the upland the thermometer descends to minus 38 deg. This would not render these trenches absolutely untenable, but would present great difficulties in working them. Even in modern shafts and galleries, that are closed by self-shutting doors, frost penetrates to a depth of twenty and thirty fathoms. It is frequently necessary to put stoves in the upper levels, in order to prevent their being filled with ice. It would, therefore, be barely possible, by no means profitable, to work in open trenches during winter. The miners could readily bring with them in the spring supplies for three months, and before these were exhausted the same craft might return for additional supplies. After spending the months of summer, the miners could return to their homes for winter, carrying with them the mineral obtained during the season.

In relation to their dead, it may have been a custom, perhaps a part of their religion, to restore the bodies to their friends. If the number of operators was not great, and the mortality was no greater than it is now, this would not have been a great burden. In case there were no women and children, the proportional number of deaths would be less than at present. It is now, for the season of navigation, not far from five in 1,000, including females and children, and including also those killed by accident.

All the ancient excavations hitherto examined could have been made with our means of working, at less expense than has been incurred during the last ten years. But we must allow much for the imperfect modes of operating, and thus increase the number required to do the same work; we must also, on the other hand, conclude that the old mines were wrought a great length of time, and infer that a less mining force was kept up than we have in our times.

In the prosecution of mining in this remote region, not only would the deaths be few, but among them such distinguished persons as were entitled to sepulchral mounds or monuments would not be found in great numbers. The absence of artificial mounds, therefore, need not excite surprise.

The Mound-builders consumed large quantities of copper. Axes, adzes, chisels, and ornamental rings are so common among the relics in Ohio as to leave no doubt on this subject. We know of no copper-bearing veins so accessible as those of Lake Superior to a people residing on the waters of the Ohio. Neither are there any others now known that produce *native metal* in quantities to serve as an article of commerce. Specimens of pure copper are found in other mines of North America, but not as a prominent part of the lode. The implements and ornaments found in the mounds are made of metal that has not been melted. They have been brought into shape *cold wrought*, or at least without heat enough to liquefy the metal, and were therefore produced from native copper. In the Lake Superior veins spots of *native silver* are frequently seen studding the surface of the copper, united or welded to it, but not alloyed with it. This is not known of any other mines, and seems to mark a Lake Superior specimen wherever it is found. It also proves conclusively that such pieces have not undergone fusion, for then the pure white spots would disappear, forming a weak alloy. Copper with blotches of native silver has been taken from the mounds. Dr. John Locke, of Cincinnati, possessed a flattened piece of copper weighing several pounds, which was found in the earthworks at Colerain, Hamilton County, Ohio, having a spot of silver as large as a pea forming a part of the mass.

At the first view of the logs which supported the mass of the Minnesota vein, the marks of the tool by which they were cut brought to mind the old copper axes I had seen in Ohio figured by Mr. Squier. The cut was about an inch and three tenths wide, not smooth like that of a perfectly sharp edge, and not deep enough for a modern ax or hatchet. No such axes have been found on Lake Superior. Those of Ohio may have been used as a chisel, although Mr. Squier thinks a handle was attached to them. The difference between the ax and the chisel is principally in the taper of the ax toward the head. No groove or eye has been noticed by which to insert a handle, but the Peruvians had means of fastening a handle to a similar instrument without either. There are also chisel-like tools from the Ohio mounds almost identical with those I have already figured. James McBride, of Hamilton, Butler County, Ohio, has in his possession four of them, found in 1855 near that place, that may be regarded either as chisels, axes, or adzes.

How much time has passed since these mines were wrought, or since they were abandoned, is a question of great interest. The timber found in some of the ancient mines is in a better state of preservation than that of the Ohio mounds; but it does not follow that it is more recent. Most of the pieces exhumed were covered by water or wet earth. In a northern climate the decay of wood is slower than in warmer regions. The timber itself is mostly resinous, which assists in its preservation. The wooden cobwork that remains in the Ohio tumuli, hitherto examined, always lies above water, and the loamy earth in which it was buried does not wholly exclude the atmosphere.

In the Grave Creek mound the timber was very much decayed, but the chambers, including the skeletons, were elevated above the natural surface, and the surrounding earth was dry. These circumstances being considered, it does not follow that the wood work of the mounds is the most ancient because it is the most decayed.

The living trees now standing, with their roots entwined among the mauls, skids and shovels of the old miners, are reliable witnesses as to the least space of time since the mines were abandoned. The age of such trees varies from 300 to 350 years. Beneath the shade of these patriarchs of the forest are the prostrate and rotten trunks of a preceding generation.

General Harrison, in a discourse before the Historical Society of Ohio, adds another score to the tally of ages that have passed since the earthworks were evacuated. When ground that has been cleared of its timber is abandoned, the second growth differs from the first in kind. It is not until several generations of trees have disappeared, that such places produce the varieties which constituted the original forest. The same thing is observed on Point Keweenaw, where a sweeping fire has consumed or deadened the resinous trees of the mountains, the first succeeding growth is that of birch and aspen.

In process of time, however, the balsam, cedar, pine, and hemlock resume their ancient domain, overshadowing and obscuring the deciduous trees. On the ancient burrows, and in the old pits of Lake Superior, the same kinds of timber flourish now as are observed in the surrounding forest. These works could not have been carried on without destroying the growth of timber of that day. Before the pines, and other evergreens that now occupy these places, overcame the birch and aspen trees, one or two generations must have passed away. Is it going too far, on the strength of this evidence, to place the *abandonment* of the mines at a distance of 500 to 600 years from our times?

There may have been inhabitants covering large territories for long periods who have disappeared without leaving any monumental evidences of their occupation. If the North American Indians had been destroyed by a general pestilence before Pamphilo de Narvaez landed in Florida, what traces of them should we be able to find? They have left no distinctive marks of their existence impressed upon the soil. Some faint signs of cultivation in the shape of little hillocks or hills of corn, not entirely obliterated as yet, are the sole vestiges of centuries. But avoiding all mere conjectural speculations, the following conclusions may be drawn with reasonable certainty:

An ancient people extracted copper from the veins of Lake Superior of whom history gives no account.

They did it in a rude way, by means of fire and the use of copper wedges or gads, and by stone mauls.

They had only the simplest mechanical contrivances, and consequently penetrated the earth but a short distance.

They do not appear to have acquired any skill in the art of metallurgy, or of cutting masses of copper.

For cutting tools they had chisels, and probably adzes or axes of copper. These tools are of pure copper, and hardened only by concentration or beating when cold.

They sought chiefly for small masses and lumps, and not for large masses.

No sepulchral mounds, defenses, domicils, roads or canals are known to have been made by them. No evidences have been discovered of the cultivation of the soil.

They had weapons of defense or of the chase, such as darts, spears, and daggers of copper.

They must have been numerous, industrious, and persevering, and have occupied the country a long time.

Ancient Works in the Ohio Valley. From Pre-historic Races. (By J. W. Foster.)

The ancient earth-works in this valley have been so elaborately described by Squier and Davis, that I shall only refer to their labors so far as may be necessary to illustrate the ethnography of the United States. Not only are the banks of the Ohio at frequent intervals crowned by these structures, but those of the subordinate streams, such as the Wabash, the Scioto, the Miami, and the Muskingum, entering from the north; and those from the opposite side, such as the Kenawhas, the Cumberland, and Tennessee. The number of tumuli in Ohio alone is estimated by the authors before referred to at 10,000, and the number of inclosures at from 1,000 to 1,500. Ross County, of which Chillicothe is the capital, contains 100 inclosures and 500 mounds. These facts, I think, clearly indicate that this region must formerly have sustained a dense population, who derived their support mainly from agriculture.

In many of these works we met with a feature which plays but a subordinate part in those before described, but which here becomes the most conspicuous, and impresses the beholder most forcibly as to the unity of design and mathematical precision which have been carried out in their construction. I refer to the elaborately constructed walls of earth or stone with which the mounds are inclosed. In these walls the geometrical figures of the square, the circle, the octagon, and the rhomb are represented; there are, too, gateways, parallel lines, outlooks, and other forms—the whole forming an intricate and yet harmonious system.

The most intricate, if not the most gigantic of all the Mound-builders' works, occur in the Licking Valley, near Newark. They occupy a plain between Raccoon Creek and the south fork of Licking Creek, which is elevated from thirty to fifty feet above those water-courses, and extends over an area of two square miles.

I can only give a general description of the magnificent system of works here displayed. Starting at the south the observer finds himself inclosed in a nearly circular embankment, twelve feet high and fifty feet broad at the base, with an interior ditch seven feet deep and thirty-five feet wide. At the gateway, which is marked by two parallel lines eighty feet apart, the parapets rise to the height of sixteen feet, with a ditch thirteen feet deep, making the altitude in the interior about thirty feet. These walls do not form a true circle, the respective diameters being 1,250 and 1,150 feet. The area inclosed is upward of thirty acres; and this site was fixed upon, and none could be more picturesque for holding one of the annual State fairs. In the center is a mound in the shape of a huge bird-track, the middle toe being 155 feet, and the other two 110 feet in length. In front is a semi-lunar embankment, slightly elevated, which is about 200 feet in length. No one whose mind is susceptible to whatever is grand in nature or in art can view with indifference this magnificent work; not in ruins, except so far as it may have been crowned with palisades, but as perfect as on the day of its abandonment. "Here," as Squier well remarks, "covered with the gigantic trees of a primitive forest, the work truly presents a grand and impressive appearance; and in entering the ancient avenue for the first time, the visitor does not fail to experience a sensation of awe, such as he might feel in passing the portals of an Egyptian temple, or in gazing upon the ruins of Petra of the Desert."

Passing out of the gateway, a broad passage, lined by walls of no great height, leads to an irregular square, containing about twenty acres. A low mound marks each corner, and also each central entrance, except in the west wall. From the northeastern gateway there extend parallel lines, connecting with a series of low walls, as intricate almost as a Cretan labyrinth, and there is an arched line of circumvallation, embracing numerous low mounds and one small circle. Near the center of the northwest wall there is another gateway, with a broad and gently curved avenue, leading to the octagon, which incloses an area of fifty acres. The angles of this structure are not coincident, although the sides are nearly equal. Opposite each entrance there is a pyramidal mound, about five feet high, and eighty by one hundred feet at the base. From the gateway on the southeast side, parallels, three hundred feet long and sixty feet apart, conduct the observer into another *true* circle, about one-half mile in circumference, and enclosed an area of twenty acres. Outside the circle and opposite gateway there is a work of peculiar structure. "It would seem," remarks Mr. Squier, "that the builders had originally determined to carry out parallel lines from this point, but after proceeding one hundred feet, had suddenly changed their minds and finished the inclosure, by throwing up an immense mound across the uncompleted parts. This wall, which may be taken as constituting a part of the wall of the inclosure, is one hundred and seventy feet long, eight feet higher than the general level of the embankment, and overlooks the entire work."

From the octagon, parallel lines diverge southwest, which may be traced for two miles. Similar parallels, nearly a mile in extent, diverge eastward, inclosing a series of circles about two hundred feet in diameter, together with a series of less diameter, and form a line of communication between the different parts of the system.

A pond, occupying an area of about one hundred acres, now drained, existed just outside the works, and its western margin was marked by four inconspicuous mounds.

No one, I think, can view the complicated system of works here displayed, and stretching away for miles, without arriving at the conclusion that they are the result of an infinite amount of toil, expended under the direction of a governing mind, and having in view a definite aim. At this day—with our iron implements, with our labor-saving machines, and the aid of horse power—to accomplish such a task would require the labor of many thousand men continued for many months. These are the work of a people who had fixed habitations, and who, deriving their support, in part, at least, from the soil, could devote their surplus labor to the rearing of such structures. A migratory people, dependent upon the uncertainties of the chase for a living, would not have the time, nor would there be the motive, to engage in such a stupendous undertaking.

When in the spring of 1788 the first settlers, under the Ohio Land Company's purchase, arrived at the mouth of the Muskingum, where they proposed to lay the foundations of a town, they were astonished at these evidences of former occupancy by a people who had some claims to be ranked as civilized. The Directors passed a resolution, reserving the two truncated pyramids and the great mound, with a few acres attached to each, as public squares. The latter is now used as a public cemetery; and the rites of Christian burial, as enacted there each year, are probably not more solemn and impressive than those which were enacted upon the same spot centuries ago, by a people whose very name and lineage have become lost.

These works, as shown by the survey of Colonel Whittlesey, occupy the river terrace or second bottom, being bounded by the alluvium on the one hand and the hills on the other. The area covered is about three fourths of a mile long, and half a mile broad. There are two irregular squares—one containing fifty acres, and the other twenty seven acres—together with the crowning work standing apart, which is a mound thirty feet high, elliptical in form, and inclosed by a circular embankment. The walls of the larger square are between five and six feet high, and twenty or thirty feet broad at the base. Within the inclosure are four truncated pyramids, three of which have graded passage-ways to the summit. The largest is one hundred and eighty-eight feet long, one hundred and thirty-two feet wide, and ten feet high. These pyramidal forms are interesting, as establishing an affinity between their builders and those of the Gulf States, who, to a great extent, as has been shown, discarded the circular form. From the southern wall a graded way, one hundred and fifty feet broad, and lined by embankments from eight to ten feet high, extends for six hundred feet, to the immediate valley of the Muskingum.

The walls bounding the smaller square are less conspicuous, and there is an absence of all pyramidal structures, but at the entrance of each gateway there is a low circular mound. From the central gateway, in the southeast wall, there is an embankment extending nearly to the entrance of the circle which incloses the great mound, and to the south and east, at an early day, similar embankments could be traced, crowning the brow of the terrace, which is here delta-shaped.

The great mound near Miamisburg, Ohio, sixty eight feet high, and eight hundred and fifty feet in circumference, far surpasses in dimensions that which the Greeks erected over the body of Patroclus.

> "They still abiding, heaped the pile,
> An hundred feet of breadth from side to side
> They gave to it, and on the summit placed
> With sorrowing hearts the body of the dead."

Grottoes occupied by Mound-builders.

The conglomerate at the base of the Coal Measures, and other formations in the Ohio Valley, often crop out in bold ledges, and in many places have weathered into deep recesses with overhanging roofs, thus forming grottoes, which were undoubtedly used by the Mound-builders for shelter, and also for sepulchres, but it is difficult, in most instances, to discriminate between their vestiges and those of the modern Red Man.

About two miles west of Rome, Perry County, Indiana, in the Ohio Valley, according to MS. notes placed in my possession by Prof. E. T. Cox, in one of the rock houses, formed by a projecting ledge of subcarboniferous sandstone, fifty feet in thickness, without a visible seam (interposed between the two horizons of Archimedes limestone), occur two ancient graves, the dimensions of which are about $4\frac{1}{2}\times2\frac{1}{2}$ feet, oval in shape, and planted with flat stones, sloping inward, which form a perfect casing throughout. One had been dug into, exposing fragments of a human skeleton, but the other remains intact. The bottom of the rock house is made of fragments of stone which have fallen from the overhanging roof, intermixed with clay. This deposit has not been penetrated in the search of human relics. Without the line of the eaves' drippings is a mass of sandstone, 3×8 feet, tumbled from above, in which, and running with the rift, are two mortar-like excavations, about two feet apart, ovoidal in shape, 6×8 inches, and tapering down to the depth of twenty inches. Two excavations of a similar character were observed by Prof. Cox, near Leopold, and he was informed that others exist near Rome. Their position, far above the neighboring streams, and their direction in reference to the bedrock of the region, convinced him that they were not "pot-holes" formed by an imprisoned bowlder, but that they were of artificial origin.

According to the same authority there is a high hill bordering the valley of the Saline River, in Illinois, on which there is a walled fort, the walls being from four to five feet high, and inclosing less than an acre. On the south side access is cut off by a precipitous descent, in the form of a cliff, from forty to fifty feet in height, but on the north side the slope is gradual and very rocky. The walls conform to the crest of the hill, which is very narrow, and the form of the fortified position is that of an irregular square. Inside a number of holes, now nearly filled, are seen, which may have been *câches* for storing provisions. A narrow and zigzag passage, easily defended, leads down to the river. The inhabitants call this locality "Stone Fort."

The region, embracing the mouth of the Wabash River, in Indiana, and the Kentucky shore opposite, including Greenup and Union counties, is thickly studded with mounds. These were explored by the late Sidney S. Lyon, who in a private letter remarks, that he has seen the works of the Mound-builders in many States, but in no other locality has he ever seen anything to compare in extent and importance with those at this point. "If the mounds, ash-heaps, bone-beds, etc., are any evidence of a formerly populous and settled country, it is to be found here. In my examinations, I find nearly one hundred mounds in an area of one hundred acres."

Proceeding up the valley, we find the high banks of the river crowned at frequent points by these ancient works. At Vincennes, the Wabash is bordered by a broad alluvial tract, and the bluffs of Löess attain a height of one hundred and fifty feet. The highest mounds occur near the line of junction, and I am of the opinion that the builders shaped into form some of the knolls formed at a time when the river extended to the foot of the bluffs. In 1859, according to Mr. William Pidgeon, it became necessary to remove a mound on the alluvial track in the suburbs of the city. It was about sixteen feet in height, with a diameter of sixty-six feet, and a section exhibited five distinct strata. The first or lowest, consisted of a bed of human bones, arranged in a circle, eighteen feet in diameter, closely pressed together. Around the outer edge of this circle, the stratum was thinner than in the center. Skulls, tibiæ, ribs, and vertebræ were promiscuously mingled, as though a pile of bodies had been heaped up. Over this was a uniform layer of tough, greyish clay, thirty-three inches in thickness, succeeded by a layer of what appeared to have been ashes, with occasional fragments of bone; and above this a twelve inch stratum of surface soil; and the whole was covered with clay.

From the numerous skeletons disclosed in this excavation, and the promiscuous manner in which they were mingled, Mr. Pidgeon was disposed to regard this as a "battle burial mound."

The Cincinnati Tablet.

J. W. Foster, in the Appendix to Pre-historic Races, says: I have purposely declined to discuss the ante-Columbian relations which many conjecture to have existed through the voyages of the Northmen to Vinland, and of the Welsh, under Prince Madog, to some supposed point in the Southern States, for the reason that if such an intercourse was ever established, these people have left behind no memorials. The Runic inscription, which the Danish antiquarians profess to recognize on the Dighton rock, is to the American ethnologist but the crude picture writing of the savage. The alphabetical characters inscribed on the "Grave Creek Stone," and the "Holy Stone of Newark" with its Hebrew letters, which have called out from philologists a wonderful amount of learning, one is disposed involuntarily to associate with the famous stone which served as the basis of Mr. Pickwick's fame.

The "Cincinnati Tablet," which was supposed to bear "a singular resemblance to the Egyptian cartouche," was fresh with the dust of the graver when the artist first attempted to palm it off as a genuine relic of the Mound-builders.* "The Round Tower of Newport," instead of being a Norse monument, turns out to be but a wind-mill, built by one of the Rhode Island governors; and "The Skeleton in Armor," which the poet has wrought into a fine ballad, represented simply all that was mortal of a Narragansett Indian, rigged out in European trappings.

The Rev. Morgan Jones, who swore that in his travels among the "Doegs" of the Tuscarora Nation he found a people with whom he could converse familiarly in the Welsh language, may have been a very worthy man; but we are disposed to question the truthfulness of a statement at this day, when the author deems it necessary to fortify it by a self-sought oath.

Expressions of the Cat.

Mr. Darwin says:

"A cat when feeling savage and not terrified assumes a crouching attitude, and occasionally protrudes her forefeet, with the claws exserted, ready for striking. The tail is extended, being curled or lashed

*Whittlesey, "Archæological Frauds," 1872.

from side to side. The hair is not erected—at least it was not so in the few cases observed by me. The ears are drawn closely backward, and the teeth are shown. Low, savage growls are uttered. We can understand why the attitude assumed by a cat when preparing to fight with another cat, or in any way greatly irritated, is so widely different from that of a dog approaching another dog with hostile intentions; for the cat uses her forefeet for striking, and this renders a crouching position convenient or necessary. She is also much more accustomed than a dog to lie concealed and suddenly spring on her prey. No cause can be assigned with certainty for the tail being lashed or curled from side to side. This habit is common to many other animals—for instance to the puma when prepared to spring, but it is not common to dogs or to foxes, as I infer from Mr. St. John's account of a fox lying in wait and seizing a hare. We have already seen that some kinds of lizards and various snakes, when excited, rapidly vibrate the tips of their tails. It would appear as if, under strong excitement, there existed an uncontrollable desire for movement of some kind, owing to nerve force being freely liberated from the excited sensorium; and that as the tail is left free, and as its movement does not disturb the general position of the body, it is curled or lashed about.

All the movements of a cat, when feeling affectionate, are in complete antithesis to those just described. She now stands upright, with slightly arched back, tail perpendicularly raised, and ears erected; and she rubs her cheeks and flanks against her master or mistress. The desire to rub something is so strong in cats under this state of mind, that they may often be seen rubbing themselves against the legs of chairs or tables or against door posts. This manner of expressing affection probably originated through association, as in the case of dogs, from the mother nursing and fondling her young; and perhaps from the young themselves loving each other and playing together. Another, and very different gesture, expressive of pleasure, has already been described, namely, the curious manner in which young and even old cats, when pleased, alternately protrude their forefeet with separated toes, as if pushing against and sucking their mother's teats. This habit is so far analogous to that of rubbing against something, that both apparently are derived from actions performed during the nursing period. Why cats should show affection by rubbing so much more than do dogs, though the latter delight in contact with their masters, and why cats only occasionally lick the hands of their friends, whilst dogs always do so, I can not say. Cats cleanse themselves by licking their own coats more regularly than do dogs. On the other hand, their tongues seem less well fitted for the work than the longer and more flexible tongues of dogs.

Cats when terrified stand at full height, and arch their backs in a well known and ridiculous fashion; they spit, hiss, or growl. The hair over the whole body, and especially on the tail, becomes erect. In the instances observed by me, the basal part of the tail was held upright, the terminal part being thrown on one side; but sometimes the tail is only a little raised, and is bent almost from the base to one side. The ears are drawn back and the teeth exposed; when two kittens are playing together the one often thus tries to frighten the other. From what we have seen, all the above points of expression are intelligible, except the extreme arching of the back. I am inclined to believe that, in the same manner as many birds, whilst they ruffle their feathers, spread out their wings and tail, to make themselves look as big as possible, so cats stand upright, at their full height, arch their backs, often raise the basal part of the tail, and erect their hair for the same purpose. The lynx, when attacked, is said to arch its back, and is thus figured by Brehm. But the keepers in the Zoological Gardens, have never seen any tendency to this action in the larger feline animals, such as tigers, lions, etc., and these have little cause to be afraid of any other animal.

Cats use their voices much as a means of expression, and they utter, under various emotions and desires, at least six or seven different sounds. The purr of satisfaction, which is made during both inspiration and expiration is one of the most curious. The puma, cheetah, and ocelot, likewise purr; but the tiger when pleased, emits a peculiar short snuffle, accompanied by the closure of the eyelids. It is said that the lion, jaguar, and leopard, do not purr.

From *Die Silurische Fauna des Westlichen Tennessee.* By Dr. Ferdinand Rœmer. [Translated from his Journal].

Astylospongia Stellatim-sulcata. [Dr. Ferd. Rœmer.]

A globular sponge, varying in size from that of a hazle-nut to that of a walnut, whose surface is covered with furrows, that run together in centers, that are irregularly distributed over the surface, and of an obscurely stellate form.

There is no particular point on its surface from which one may start its description. The curve and structure of its surface is altogether so similar, that one can not distinguish between a top and a bottom. Larger openings are not perceptible upon the outer surface. This especially distinguishes this species from *Astylospongia præmorsa*, many specimens of which, on account of the obscurity of their furrows, would otherwise be mistaken for it. It exhibits in its interior, a texture composed of countless little spicula, grouped in the form of stars, entirely analogous with the *Astylospongia præmorsa.* On the other hand, there are no such large canals radiating from the center, as are to be observed in the other species, and the concentric canals observable therein seem to be here altogether wanting.

General Appearance: I have before me fourteen specimens of this species, the smallest of which is of the size of a hazel-nut, and the largest of which is of that of a walnut. Besides the difference in size, these specimens may be distinguished especially in respect to the clearness and number of their furrows. Several of these specimens are in part still embedded in pieces of Silurian limestone. The substance of the petrification of all these specimens is as with *Astylospongia præmorsa* siliceous.

Astylospongia inciso-lobata—(Rœmer).

A round, depressed spheroidal sponge, which is divided with from six to eight deep, incisive furrows, running down over the sides from the top, and reuniting in the center of the under side, forming at the circumference unequal rounded lobes. The texture is everywhere equally compact or finely porous. Larger openings are not to be observed, and a surface attachment or epitheca is wanting. Some specimens, of a form almost entirely globular, and hardly depressed, with irregular shallow furrows, very much resemble the preceding species, and it is possible that both species are connected together by interlinking forms or transitions.

Its inner structure was not observed, and in that far its belonging to that species was left in doubt. On the other hand, the absence of an epitheca is beyond all doubt.

Of the six specimens before me the largest is an inch in diameter. This is embedded in a piece of hornstone, with which is ingrown at the same time a piece of the calix of an *Encalyptocrinus.*

Astylospongia imbricato-articulata—(Rœmer).

Incomplete cylindrical, rather thickening toward the top, with its surface covered with ring-formed intervals from top to bottom. The top is concave, and at the bottom of the concavity displays from six to eight larger openings. It is observable from a cross section that these openings are the mouths of pipes, which run through the whole length of the sponge. It is also observable from a cross section that long slits, branching outwardly, and becoming by degrees smaller and more obscure, radiate from the axis toward the circumference of the sponge, running through the larger openings. In this species, too, as in the *A. præmorsa* and *A. stellatim sulcata,* the inner texture of the sponge is composed of numerous small bodies, hanging together in the shape of stars. We can distinguish these very plainly on the outer circumference, which forms the lower end of the specimen, by the fractured edges of the surfaces, in that part where the substance of petrifaction is transparent, blue-gray chalcedony. These stars, however, seem to be more irregular than in the other two species, and generally to be four-rayed instead of six. Without this concurrence of its inner structure it might be doubtful to what genus to ascribe it, as from the want of the lower end of the simple specimen, that I have before me, and from the cylindrical form of the body, it could hardly be determined.

Its almost cylindrical or rolling form and ring-like prominences make this species somewhat resemble the *Scyphia-articulata* (Goldfuss), and also the *Scyphia-cylindrica* (Goldfuss), var. *rugosa* of Streitberg. However, the Jura species are wanting in the inner perpendicular pipes belonging to our species, and *Scyphia-articulata* is, moreover, distinguished by a beautiful cross-barred surface.

Palæmanon cratera—(Rœmer).

A sponge, bowl or goblet-shaped, with its whole surface covered with dispersed larger openings, having between them smaller openings, like the points of needles. The larger openings are much more distinct and better defined upon the upper depressed surface than upon the side surfaces, upon which they are often wholly unrecognizable. Irregular furrows or streaks are drawn from the hollow of the edge that circumscribes the upper side running over the outer side. The lower end is formed by a horizontal plane, truncated surface, similar to that of the *Astylospongia præmorsa.* Sometimes, but more seldom, it is rounded off. At times, too, the upper surface is much less depressed. In those cases forms are presented which are similar to the *Astylospongia præmorsa,* and it seems to me not at all impossible that at one time complete transformations between the two species occurred.

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Prof. Frey, of Zürich, and some American Teneina.—By V. T. CHAMBERS, Esq., Covington, Kentucky.

How few persons seem to know, or be alive to the world of beauty which surrounds them. With the mass of mankind who give no attention to nature or her beauties, this can not be otherwise; but even with those who really love nature, who love to study her works and ways, how little of it is known outside of some special province to which they have applied themselves. The specialist gives himself up to the study of his favorite branch of science, and finds himself fully occupied with the beauties, or the material for thought and speculation which he finds there. But there is another class of persons who have much love for nature, who would gladly walk in her quiet, pleasant paths, but who have not the time or means to devote themselves earnestly to the pursuit of science; yet, for these also is a rich field of instruction and amusement open, did they only know how to look for it, where to find it. And yet no great learning, or expense, is necessary for the gratification of such simple desires as these. Let us point out a single instance, and it will suffice to show the way to others.

Pluck yonder leaf from the sugar maple, on the under side of it you will find a blotch, looking like a dead spot in the leaf; it approaches an oval form, and evidently the deadened portion of the leaf has shrunken, so as to cause a little curve in the leaf; pluck another, a dozen, dozens of them, the blotch is always alike. Singular that so many dead spots, of the same size and appearance, should be found on so many leaves, if they are merely dead blotches! But straighten out one of the leaves to its original form, as near as may be, and behold the deadened portion of the under surface tears open, showing the upper surface nearly intact, and a little cave formed inside of the leaf by the shrinkage of the under surface, and in this cave we find only a little caterpillar! Nothing very worthy all this trouble in that, certainly. Well, turn over one of the leaves, and then on the other surface you will find a blotch of a different kind; it is flat, the upper surface of the leaf is deadened and loosened, but there is no cavity under it. Open it. We find still only a caterpillar. It differs, however, from the preceding one; that was like ordinary caterpillars, nearly cylindrical—this is depressed, almost flat. Pluck yet this other leaf from the wild cherry; you will observe on its upper surface a very narrow, winding black line, bordered with crimson on each side. It winds and curves about like the undulations of some tiny, gaily colored serpent, yet a three cent piece will cover the whole of it out of sight. Hold it up between you and the light; at its larger end you will see still only a caterpillar, exceedingly minute, and differing from each of the others. These are what we call mined leaves, and the mines are those of three, perhaps four species of *Micro-Lepidoptera.* But what are *Micro-Lepidoptera?* Well, you may translate it literally, little scale-wings, just as you may call butterflies and large moths, big scale-wings. They are little moths of the family *Teneina;* the same family to which "the moth," that good housekeepers complain of, belongs. But the family is a very large one, and, to say the truth, many members of the family seem to be very little akin to each other, except in a Darwinian sense. The clothes moth, the housekeepers' enemy, has nothing to brag of in the way of beauty, and certainly still less in the way of usefulness; and besides, although it has managed to give its name to the family *Teneina*, it is hardly in any sense a fair representative of the family; in fact, it is rather a disgrace to the family. But the little leaf-mining species contain among them the gems, I had almost said, of the animate creation. Minute as they are, and requiring the aid of a good pocket lens, or better still, a microscope of low power, to bring out their beauties, they excell by far, in my judgment, all the flowers, birds, butterflies, etc., of the animate kingdom. Perhaps a majority of the plants in any one region, certainly a great number of them, have each a species mining its leaves in the larva or caterpillar state. But it is not in that condition that they are beautiful, by any means. All of their adornment is lavished on the imago, as naturalists call it, that is, the perfect insect, the moth, after it has passed through its metamorphosis, and taken flight on its long fringed wings. And if these lines should fall under the eye of any of our lady readers, we advise them to collect a lot of mined leaves from a variety of plants, assort them, and place each different kind of mine in a separate, small glass jar, keeping the jar closed, so as to keep the leaves fresh as long as possible, and await patiently, say a week or two, for the moths to emerge; then place an empty glass jar over the first one, so that the moths will run or fly up into it; close them up in it, and kill them with the fumes of a few drops of chloroform, being careful all the while not to injure them by rubbing off the scales which clothe them, and then examine them with the lens, or microscope, as before mentioned, and if I have exaggerated their beauty, why, it will be nothing more than other men have done for the "lady reader" aforesaid, many a time before.

But what has all this to do with the Zürich Professor? Why, this much: It has served to introduce to your acquaintance the *Micro-Lepidoptera*, as if you will but study the few species mentioned below, you will be enabled to judge whether the "American colleagues," as the Professor calls them (*i. e.*, Dr. Brackenridge, Clemens, late of Pennsylvania, and your humble servant, the writer), have been guilty of the sins of omission and commission with which he charges us, or *vice versa.*

Prof. Frey, of Zurich, and Mr. J. Boll, of Baumgarten, have lately issued a little *brochure* on some of the *Micro-Lepidoptera* of the United States, which seems to call for some notice at the hands of students of this group, in this country. The part of Mr. Ball in the matter appears to have been confined to collecting insects with their mines and larvæ, with information as to their localities, habits, food, etc., and it seems to have been well performed. The descriptions of species and criticisms upon the work of others are evidently from the pen of Prof. Frey, and to him the praise or blame attaches so far as praise or blame are due for the *brochure* now before us.

It appears from an introductory notice that a large collection of the mined leaves of differerent species of plants, from the vicinity of Cambridge, Massachusetts, was made by Mr. Boll, in the fall of 1872; but unfortunate private events caused Mr. Boll to return to Switzerland in the same winter, " in stormy haste," as the Professor tells us, so that he could not assort the material, but was compelled to jumble together the mixed mass of leaves of various kinds; and, as any one accustomed to rearing *Micro-Lepidoptera* knows, very little that was satisfactory could result therefrom, for most of the larvæ would fail to come to maturity, and of those that did, very little could be learned, as to the food-plant mine and larvæ. What the species were which Prof. Frey succeeded in describing will be mentioned further on.

The Professor informs us that, *as far as practicable*, he has compared the species described by him with the descriptions of Brackenridge, Clemens, Chambers, and others, but much, in fact most, is left "in uncertainty by these short and defective descriptions." Now, taking this *brochure* as a fair specimen (which we hope and believe it is not) of the Professor's work, the shame of American Micro-Lepidopterists would be great indeed, if their labors, either in the way of descriptive work, or in careful original investigation, should be found to fall to the low level of this little pamphlet, which, for the Professor's reputation, had better have remained "in the womb of time forever." It would be easy work for any Micro-Lepidopterists to determine by a single comparison of the descriptions in this pamphlet, with as many taken at random from the descriptions of Dr. Clemens, which is most justly chargeable with "brevity and uncertainty, and defectiveness and obscurity." The Professor is profuse of good advice to Americans, to look to Europe and European authors, and to what they have done as our ensamples; but, unfortunately, this pamphlet does not incline us to look further in that direction, and I shall show such miserable carelessness, or incapacity, on the Professor's part to learn what has been done by Dr. Clemens and others in this country, that it will not be necessary to comment on the absurdity of the *dictum* quoted above.

Now, our subjects, the "micros," are very little, but one thing is yet smaller, one that has appeared to me the infinitely little—and that is the practice of indulging in personal quarrels among naturalists about their work, the practice of calling hard names, and of accusing each other of all the crimes named in the decalogue, and many not there named, as *e. g.*, of stealing each others species; that is, giving a new name, or it may be, a new description to a species already well known, and then attaching the name of the author of a new description to the name with which he has rechristened the old species, like a tail to a kite, or as if the author expected the rechristened insect to fly away into immortality, bearing the author's name with it. Authors' quarrels do no one any good, the authors themselves become ridiculous, they batter each other with bad names, and make their readers laugh at them, if they do not become too much disgusted for laughter. I therefore shall have no quarrel with Prof. Frey, on account of the unfounded charges against American Micro-Lepidopterists above mentioned, nor on account of any injury, real or supposed, done to me by his little pamphlet, but for the sake of the truth of history, and to prevent mistakes and confusion into which the pamphlet might lead future investigators as to nomenclature, habits of insects, etc., the pamphlet must have criticism. In fact, I do not think that the charges of obscurity, brevity, etc., against American entomologists are meant to give rise to any ill will. It is only the natural, paternal way of the European entomologist when writing of the inferior co-labour in the barbarous West; the quiet, perfectly natural assumption by the Professor, of the superiority of European work and European notions over those of outside barbarians, who are being "educated up;" and it makes no sort of difference whether the Professor has ever seen or known anything about the subjects under discussion, nor whether the outside barbarian has been all his life as familiar with it as "household words." As Prof. Frey, therefore, meant no offense, none shall be taken; we shall write in perfect good nature, only for the sake of science and the truth, using the knife only to lay bare such blunders and errors as the Professor may have fallen into; and when, as hereafter mentioned, he writes *Lithocolletis gemmea*, Frey, for *Parrectopa robiniella*, Clem., I shall not accuse him of tying his tail to another boy's kite, but shall content myself with simply showing that the insect is *P. robiniella*, Clem., and can not, nor ever could, possibly be considered a *Lithocolletis*. So, I propose to show that the confusion among American Micro-Lepidopterologists, of which the Professor says so much, exists only in the mind of the Professor; and, when the Professor failed to recognize "common species," undescribed in any descriptions of American writers, it may possibly be the fault of the Professor, and not of the descriptions, or the species may be new instead of "common species;" for American Micro-Lepidopterists know what multitudes of undescribed species are yet to be found within the limits of the continent.

But I must, I fear, sometimes accuse the Professor of a disposition for species-making; and as to the charge of brevity in descriptions, whilst we are glad to plead in extenuation so good an example in this respect as Prof. Frey has set us in this *brochure*, yet, I must remind him that brevity is the soul of some other things besides wit, and that a description which by an apt phrase, or by catching and noting, as it were, by intuition, or at a single glance, the real specific characters, fixes the species, is worth a dozen pages of circumlocution, which attempt to define by words some indefinable tint or shade, by which some unnamed color passes into some other combination of prismatic hues, incomprehensible to any sense but vision, and unnameable by words; as frequently happens amongst creatures of such beautiful, varied, and ever-changing hues, as are some of these little beings, where, literally, sometimes each several scale performs the office of a prism, and the colors change with every movement of the object or the eye; in view of all this, I can not see the urgent necessity that Prof. Frey should "insist against Prof. Zeller, that" a small portion of an insect, about one eighth of an inch long, is a "darker shade of yellowish" instead of a "brownish red," as Prof. Zeller asserts. In fact, no one can successfully paint in words, however profuse, the infinitesimally fine gradations of color among these many-hued beings. The Professor seems to believe fixedly in the fixedness of species, and a specific description is incomplete, brief, or wanting in some other essential quality, which does not enable him to recognize, without trouble, every specimen of the species, which may be brought before him—however variable the species and however changeable its prismatic hues; there would seem to be no room for variation in his system, so far as species are concerned, though he is by no manner of means so strict as to genera; most Micro-Lepidopterists attach great importance to the neuration of the wings as determining generic differences. Not so our Professor. I have alluded above to his displacement of *Parrectopa robiniella*, Clem., and his misplacing it in *Lithocolletis* as *L. gemmea*, Frey. The neuration of the species is distinctly and unequivocally that of the genus *Gracilaria*, it has scarcely a character in common with *Lithocolletis*, yet the Professor places it in the same generic group with true species of *Lithocolletis*, and even such aberrant species as *Lithocolletis ornatella*, which has the neuration unusually simple; and he includes in the same group a new species, which he calls *Lithocolletis aenigmatella* (an excellent name for such a description!) which, according to his own description, ought only doubtfully, if at all, to be placed in that genus; thus he groups in *Lithocolletis* doubtful and true forms of that genus, together with a species having the characters of a *Gracilaria*, and in this group he describes several new species, and mentions several others, which he says he can not recognize in the descriptions of his American colleagues. Do such new and unrecognizable species belong in *Lithocolletis* at all? Was it not an error to place them there? that is, in *Lithocolletis*, as recognized by all other entomologists; indeed, given such a heterogenous group as will contain *Parrectopa robiniella*, Clem., *Lithocolletis Argentinotella*, Clem., *L. ornatella*, Cham., and *L. Aenigmatella*, Frey, and what may not be placed in it? In looking up the new and unrecognized species, one would feel no certainty that the true *Lithocolletis* is the group in which they are to be found they might belong anywhere else, for all this *brochure* shows.

Another idea that the Professor loses no chance of reiterating, is the wonderful likeness of the new and old world *Teneina*, as if he had made a discovery of the "first water." There is nothing whatever new in it; every man has already learned that much, who has seen a dozen of our indigenous species, and has compared them with as many from Europe, or with the figures in Stainton's Nat. Hist. Tin. The *Teneina* differ in this but little from other insects, except that like most other lowly forms of life they are more universally dispersed. The genus *Gracilaria*, for instance, is found in England, Asia, and Holland, and in the United States from Cambridge to California, and the closely allied genus *Coriscium* goes with it. But the species of the United States are like those of other countries besides Europe, in some respects. Thus *Coriscium albanotella*, Cham., though not strictly resembling any species known to me, yet resembles rather more than any other *Glacilaria nitadula*, from New Holland, figured by Mr. Stainton in Trans. Lond. Ent. Soc., 1863, plate 10, fig. 9, as to the form of the marks, though the ground color is more like *G. callicella*, Stainton, *loc. cit.* But then, on the other hand, a collection of "micros" from Texas, containing over seventy species, differ more from the *Teneina* of Kentucky than these do from those of England.

Upon one other point I likewise wish to take issue with the Professor, and at the same time with such other Micro-Lepidopterists as have not been to a great extent collectors of these insects in all their stages. My experience in this respect has not been small, and I *know* that the common opinion, or at least the common mode of expression, as that there are two (or more) broods of a certain species in a year, or, that the larvæ may be found at such a time, and the pupæ at such a time, and the imago at such a time, and not other times, are erroneous, so far, at least, as most of the little leaf-mining species are concerned. Some species hybernate in the imago state (as *Lithocolletis robiniella*, Clem.), some as pupæ, as do most species, and others as larvæ (as does *L. Cincinnatiella*, Cham.) They make their first appearance at different seasons. *L. robiniella*, Clem., of course may be found early; *L. cratægella*, Clem., *Tescheria*, *malifoballa*, Clem., and others, appear here in March; *L. lucidicostella*, Clem., and *L. basistigella*, Clem., and others a little later, and *L. ornatella*, Cham., *Gracilaria* (*Parrectopa*) *robiniella*, Clem., the species of *Antispila Aspidisca*, and some others, do not appear till early June, unless May be very warm. Most forms begin to oviposit in the leaves in May, but the locust-feeding species usually do not until June; and I assert it as a fact, which any one can verify, that, constantly, with any one of these species, the larvæ may be found in their mines at all times, from their first discovery until the fall of the leaves, and the same is true of the pupæ, and of the moths, from their first appearance until the leaves fall; there is no interlude. Of course there are only a certain number of descendants from any given female, but that does not affect the case. They are constantly laying eggs, constantly undergoing their metamorphoses, and one so-called brood is larval, while at the same time another is pupal, and another in the imago. It is altogether a matter of climate. *Gracilaria (Parrectopa) robiniella*, Clem., ceases to mine only when the leaves fall, that is, in the central States in October or November, but in Southern Louisiana they may still be found feeding in December.

But, leaving these general remarks, let us turn our attention especially to the species which Prof. Frey has dealt with in this little pamphlet, and to his fitness for the task which he has undertaken, of describing intelligently, and identifying American *Micro-Lepidoptera*, and of criticising American laborers in the same field. He describes four species of *Gracilaria*; the first is *G. superbifrontella*, Clem., and, wonderful to relate, Dr. Clemens has been guilty of so much brevity in his description, that he has described the insect in all three of its states, and its mine and food plant, in sixteen lines of coarse print, so well that the Professor can not help recognizing it at a glance, whereupon he devotes nearly twice as much space to confusing the subject as Dr. Clemens did to making it clear. Prof. Frey then gives us a characteristic description of a species under the name *Gracilaria elegantella*, Frey, with the correct statement, that none of Dr. Clemens' species approach it; but in which we recognize at once, on carefully comparing his description with our specimens, *Gracilaria Packardella*, Chamb., Canadian Entomologist, vol. iv., p. 27.

The Professor gives this third species the name *Gracilaria mirabilis*. I am not satisfied about this species. Prof. Frey's descriptions, when compared with specimens of *G. geiella*, Cham., Can. Ent., vol. vi. (described erroneously as *G. plantaginisella*, vol. iv., p. 10), indicate, so far as I can understand the Professor's description, a close similarity, if not identity, between the insects described by Prof. Frey and myself, at least, as to the markings on the wings; but the markings of the head and its appendages seem to differ. Future investigations must settle the matter as to whether *mirabilis* is a synonym for *geiella*. I am not able to recognize in the Professor's fourth description any species known to me—he calls it *G. astericola*, and states that it mines the leaves and corymbs of *Aster cordifolia*, which species and others of aster are numerous in this locality; but I have never found the leaves of any of them mined by any insect except by *Butatis matutella*, Clem.

Prof. Frey then gives a species of *Coriscium*, which, if I understand his description, is certainly new. Dr. Clemens described no species of this genus, and I have described but one, *C. albanotella*, a very handsome and singular oak-feeding species, and it is certainly (I think) not Prof. Frey's *C. Paradadoxum*.

The Professor has done wisely in stearing clear of the genus *Ornix*, a very troublesome one to manage, in this country at least.

The next genus which the Professor takes in hand, is *Lithocolletis*, and his first species which he calls *L. quercitorum*, is evidently *L. Fitchella*, Clem., which had previously been described by Dr. Fitch as *Argyromiges quercifoliella*, but the specific name being already in use for another species, Dr. Clemens changed it to *L. Fitchella*.

The next species, *L. Hagenii*, is probably new; at least, I am not able to recognize in Prof. Frey's description any *Lithocolletis* yet made known in this country.

Then come some remarks on the question, whether a micro which he bred from the leaves, and calls *L. Longestriata*, is identical with *L. Argentifintriella*, Clem., a question on which I, of course, can say nothing, not having the insects, nor full descriptions of them.

Prof. Frey's next species is marked, provisionally, *L. alniella*, Zell. He does not describe it, but states that he had a male, which, at first sight, he believed to be this species, but closer inspection yields doubts. The Professor has been lucky if he has had either a new or old species from a mine in an alder leaf. With the closest search, I have never been able to find a micro of any kind feeding in or on alder leaves, and had given them up in despair. He also mentions rearing (from what?) a species which he does not name or describe, but which he states resembles the European *L. acerifoliella*, Zell., (*L. sylvella* of Stainton's Nat. Hist. Tin.,) and it is probably *L. hamadryadella*, Clem.

I am unable to recognize in Prof. Frey's new species, *L. intermedia*, any species known to me. It evidently belongs to the same group with *L. celtisella*, Cham., which is our nearest congener of *L. corylifoliella*, as figured by Stainton, Nat. His. Tin., vol. ii., but is nearly as close to *L. Viminiella*, *loc cit.* It differs from *Corylifoliella*, in having the ground color frequently much brighter, much more densely flecked with black; the first dorsal and first costal white streaks touch each other, are not quite so oblique as in that species; are very distinctly dark margined, internally, and the rather dense dusting of the apex appears to be on a faint white ground. There are also the usual lines on the thorax. But it is astonishing what a different insect it appears to be when worn or rubbed a little, and even frequently without, in its natural condition; it is a *very* variable species, especially as to the intensity of the ground color and markings; some species being very pale, and with the markings and dustings very indistinct. I am almost persuaded that *L. nonfasciella*, Cham., is not a true species, and that it was described from varieties or worn specimens of this species. But then there can be no probability that

L. intermedia will also prove to be only one of the million varieties of this species. The apical spot and little costal streaks, near the apex, identify it sufficiently. *Celtisella* is found in this vicinity by thousands, and, in some places, a visit at almost any hour of every day would afford a dozen specimens, from April to October. *L. obsoleta*, Prof. Frey's next species, is much more likely to be a pale or worn form of *L. celtisella* (like *L. nonfasciella*) than *L. intermedia*. I have seen pale and worn specimens of *celtisella*, to which Prof. Frey's description of *obsoleta* might apply. But this is all guess-work, from a description which does not give even the ground color, excepting by reference to another European species, which it is said to resemble in some respects.

L. mirifica, the next species, *may* be *L. ostryæfoliella*, Clem., if Prof. Frey has made it up from damaged specimens. The color and marking of the wings seem to be identical, except that *ostryæfoliella*, according to Clemens, has four costal streaks, while *mirifica* has, according to Frey, only three. But the fourth one in *ostryæfoliella* is indistinct, in the cilia, and might well escape observation if the cilia at that part of the wing were injured. The description of *mirifica* is not altogether so satisfactory as it might be, and the markings of the head do not agree with those of *octryæfoliella* so well as those of the wings, which agree in a striking manner. If not the same, it is certainly a very closely allied species. The description given of this species, and of the preceding, are nearly the same, especially as to the wings, except that, as before stated, I am rather in the dark as to the ground color of *obsoletella*, and the description does not say whether or not it has a basal streak; all of which is allowable in a Zurich Professor! *L. Scudderella*, Frey, we likewise fail to recognize in any of our species.

L. consimilella, Frey, is *tritæniælla*, Cham., or some new and very closely related species, though I scarcely doubt that it is *tritæniælla*. My only doubt arises from the statement that the breast of *consimilella* is of the same hue with the wing, and he gives no description of the thorax. The breast in *tritæniælla* is dirty whitish. Nor have we any doubt that Prof. Frey properly identified some of his specimens with *L. argentinotella*, Clem. But in the name of chaos and confusion what has *L. umella*, Cham., to do with it? Why does the Professor make *umella*, Cham., a synonymn for *argentinotella*, Clem.? As well might he make our common blue-bird (*Sylvia syatis*, Wilson) identical with the blue-jay, (*Garulus cristatus*), because he might happen to find their nests in the same tree. It is true *Argentinotella*, Clem., and *ulmella*, Cham., do happen to mine the leaves of the same tree (different kinds of elm), but let us note the differences throughout their lives, and imagine, if we can, how the Professor ever made this egregious blunder. The insects do not even belong to the same group in the genus. But first it must be mentioned that Dr. Clemens long ago announced that there were two forms of larvæ in this genus: one is the ordinary cylindrical form, which is perhaps the most common form, the other is a depressed, almost flattened form, with the ventral legs scarcely apparent; indeed, the cylindrical form seems a much more highly developed animal, internally as well as externally, than the flat form, and if the differences of the imagos were as great as those of the larvæ no entomologist would think of classing them in the same genus; yet, nevertheless, an imago derived from a cylindrical larvæ will frequently belong to the same group, and be marked very much like one derived from the flat group. No species of *Lithocolletis* is known to have larvæ belonging to both forms. *L. Cincinnatiella*, Cham., comes nearest to this. It really *seems* to have two forms, one the ordinary flat larvæ, and the other I have usually found alive in the winter, a much larger larvæ, *almost* cylindrical, but yet depressed and differing much more from the cylindrical larvæ than it does from the ordinary flat form. Its mouth parts are those of the flat form, and so are the feet, but more distinct and better developed. Consequent on differences of form, are those of life and habit. Thus the cylindrical larvæ stands erect and crawls, like any ordinary caterpillar, on its feet, and owing to this and to the form of its head and mouth, its mine *must be* tentiform, that is, the *parenchyma* is eaten out between the upper and lower cuticles of the leaf, and one side or the other becomes somewhat drawn, so that the cavity within becomes roomy and tentiform, as I before explained as to the mines of the sugar-tree leaf miners. In two species that we know, the cavity is such that the cocoon of the pupa is suspended in it like a hammock, by a thread from each end. The flat larvæ rather wriggles than crawls, and by reason of its form it does not need a tentiform mine; and by reason of the form of its head and mouth parts, it can not make one. The mine, therefore, is always flat. I have observed, also, that the flat mine and larvæ are always on the upper side of the leaf, except in the case of *L. ornatella*, and the cylindrical larvæ and tentiform mine usually, but by no means always, are found on the under side of the leaf. *L. robiniella*, Clem., and *L. tilliœella*, Cham., are standing exceptions to this rule, and I once saw a leaf of the elm with two mines of *L. argentinotella*, Clem., on the under surface, and one on the upper surface, from which I had all these specimens. Mr. Stainton (page 63, of his edition of the Clemens papers) says, he "doubts much whether we have in Europe anything like the second (flat) group of the larvæ." From an inspection of the plates in Nat. His. Tin., I suspect, however, that Mr. Stainton may be in error about this. I have made these remarks to illustrate the difference between the two forms of mine and miner, which are common in the United States, and only add the fact that, so far as I have observed, all the larvæ of white species of *Lithocolletis*, as *e. g.*, *L. argentifimbriella*, Clem., *L. Clemensella*, Cham., and the European *L. Heegeriella*, and *L. Cramerella*, have cylindrical larvæ, whilst *perhaps* most—not all by any means—of the darker colored species are of the flat group. This, however, by the way. I now proceed to notice the differences between *Argentinotella* and *Ulmella*, which Prof. Frey unites without examination:

L. Argentinotella, Clem.,	*L. Ulmella*, Cham.,
Has the mine tentiform, and nearly always on the under side of the leaf.	Has the mine flat, and always on the upper side of the leaf.
The larva is cylindrical.	The larva is flat.

As to the description of the imago, I notice only the points named in the respective descriptions by Dr. Clemens and myself, as the *Professor had no other way of learning the differences between the species, except from these descriptions. He never saw L. ulmella.*

Antenæ, silvery.	Antenæ, silvery white; the apical two thirds annulate with brownish.
Front and tuft, silvery.	Face and palp, silvery white; the tuft intermixed with golden. Legs and under surface silvery white.
Thorax, pale reddish saffron; wings of same hue, with *a rather short, unmargined, silvery basal streak.* (The basal streak is in the middle of the wing).	Anterior wings bright golden, inclining to orange, *with a white streak along the dorsal margin, from the base to the cilia, where it is deflexed, and passes on to the dusted portion of the apex, which is near the posterior* margin, and is dark brown or a white ground.
Wings with *five costal* streaks and *four dorsal streaks* of the same hue. The first costal and dorsal streaks are unmargined; the first dorsal being near the inner angle of the base, tapering to a point in the middle of the wing, from a very broad base; the first costal streak, rather slender, and only half as long as the first dorsal. The second costal and dorsal connected about the middle of the wing, and dark margined toward the base, by a line much curved in the middle. Third costal and third dorsal opposite, and each dark margined internally. The *fourth dorsal* about midway between the *fourth and fifth costal* streaks; sometimes the *fourth dorsal* and *costal* streaks with a few internal scales, sometimes unmarginal.	*Three small costal* silvery streaks; the *first and second* being near the middle of the costal margin; the second one is the largest, and the *third is small and near the apex.* There is some variation in the size of costal streaks, and in the extent of the apical dusting, and sometimes the costal streaks are faintly dark margined. (*The description does not mention dorsal streaks, because there are none.*)
At the apex is a small scattered patch of black scales.	Apex dusted dark brown on a white ground.

Now, how Prof. Frey, on these two descriptions, and with a specimen of *Argentinotella* before him, but none of *ulmella*, that being his only means of comparing the species, could conceive them to be the same, we can not conceive. But it was worse even than this, though this shows reckless carelessness in comparing the descriptions. The cylindrical larva and tentiform mine of *Argentinotella* were unknown until I published them, on p. 148, Can. Ent., about the middle of the page, and on that same page, toward the bottom, so near together that he could not cast his eye upon one description without seeing the other, and only separated from each other by a few lines on the species *L. basistrigella*, Clem., mentioning its tentiform mine and cylindrical larva, is my account of *L. ulmella*, and its flat larva and mine, and the statement that it resembled *L. basistrigella*, the next preceding species. Professor Frey got his account of *ulmella*, and his account of the mine and larva of *L. argentinotella* from that source, for they have never been published elsewhere, and yet he gives *ulmella* as a synonym of *Argentinotella!* Is this the sort of European natural history which American naturalists are invited to follow, instead of their "brevity," "defectiveness," and "confusion?" In one place the Professor expresses some astonishment that he was not able to recognize two of his species in any of our descriptions. After such work as this, the wonder would seem to be that he ever succeeded in recognizing anything.

The next species which Prof. Frey mentions, he thinks, is a variety of the European L. *trifasciella*, having "one more white hook" than the European species has; but he does not tell us where the white hook may be found. I have already suggested the probability that *L. consimilella*, Frey, is *L. tritæniaella*, Cham., and, beside, *L. trifasciella* is already too strongly marked for *tritæniaella*, and as the mine of *consimiella* is unknown, it is more likely to be *tritæniaella*, which mines the iron wood, *Oystra virginica*, on the upper side of the leaf, than it is to be *trifasciella*, which, like its European namesake, mines the leaves of honeysuckles (*Lonicera sempervirens*). I therefore concur with Professor Frey, that the species here described by him may be a mere variety of the European *L. trifasciella*. But if so, it has, probably, but recently arrived in this country, and has not as yet spread far, like *Pieris rapæ*, among the butterflies; for faithful searchings of all sorts of honeysuckles, in the Middle and Southern States, has wholly failed to furnish me a lepidopterous mine, though I have found a dipterous one abundant.

The next of Prof. Frey's species, which he calls *L. ignota*, is probably *L. helianthisella*, Cham., very similar to *L. ambrosiaella*, Cham. I think there can be little doubt of this. *L. helianthisella* was bred by me in the spring of 1872, and described, as one among many species, in a MS. furnished early in 1873 to the editors of the Can. Ent., and which has since been appearing in that periodical, as their space will admit. Professor Frey does not describe his next species, which he calls *L. Bostonica*, otherwise than by pointing out some minute points, wherein it seems to differ from the species just mentioned ; these, I think, there are not specific differences, and as to the difference of size, there is something about that which is curious, though not, I think, of specific value. I have frequently, both bred from the mines and captured minute species of *L. ornatella*, Cham., and *L. cratœgella*, Clem. ; these little specimens are not more than one half as long as those of the ordinary size, and differed from them only in size, and in having the colors less brilliant, more deadened, so to speak. The mines from which I bred them were the ordinary forms of the mines of those species, both in form or size.

The next species, *L. auronitens*, Frey, we are unable to recognize in any American species.

Prof. Frey then proceeds to what he calls the *Acacia* feeding species of *Lithocolletis.* He must, however, use the word acacia only in a very wide sense, since the European micro, *L. stetinensis*, which he seems to consider one of the group, mines leaves of Alnus (elder). We know of no species feeding on acacia proper, though all the species referred to feed on species of *Robinia*, *Desmodium*, *Amphicarpeœ* and *Lespedezia*, closely related *Leguminous* plants, except *Stetinensis*. The first species mentioned in this group, is called, by Prof. Frey, *L. ornatella*, Cham., and he states that "the mines of the *Acacia* have caused him (the Professor) great cudgeling of his head," "while he has unfortunately arrived at no definite conclusion," whilst the American entomologists, as to these, find themselves in a "wonderful confusion ;" "which, however, could be ended in one summer easy." He states that one species (what species?) was left at Cambridge, and two others were reared at Zürich, one of which reminds him of *L. stetinensis*, and which, from his short notes, must be *L. ornetella*, Cham.; and another, which is clearly *Parrectopa robiniella*, Clem., for which the Professor attempts, unjustifiably, to substitute the mine *Lithocolletis gemmea*, Frey. Now, noticing each of these points in the Professor's notice of *L. ornatella*, and *Probiniella*, we ask why does the Professor add the [?] to the noun *L. ornatella*, Cham.? If it was because of a doubt whether it really was *ornatella*, the slightest reference to the description of that species in the Canadian Entomologist ought to have satisfied him that it was the same, and if it did not, then we assure him, from his own notes on the species, that it was *L. ornatella*, Cham. If it was from a doubt whether *L. ornatella*, Cham., is not a synonym for the European species, *L. stetinensis*, we can assure him that if the account and figure of *stetinensis*, plate 5, vol. ii., of Nat. Hist. Tin., edited by Mr. Stainton, Professor Frey, and others, is at all correct, *ornatella* is a very different insect. It differs as follows: If Mr. Stainton's surmise, before mentioned, is correct, viz., that the flat larva is not found in Europe, then the larva of *stetinensis* must be cylindrical, while that of *ornatella* is flat. *Stetinensis* mines alder leaves, and the mines, as figured *loc. cit*, differ decidedly from those of *ornatella*, in the leaves of black, and flowering locust trees (*Robinia pseudaccia* and *R. Hispida*), which are smooth, placed indifferently on either the upper or the under surface of the leaves, which are not folded nor creased in any way by them. *L. stetinensis* passes the pupa state in the mine, at least I judge so from Mr. Stainton's statement, the *L. helianthum*, H. Sch., was the only species hitherto known which leaves the mine to pupate; *ornatella* leaves the mine to pupate. *Stetinensis* has the tip of the antenæ white, *ornatella* has it of the same brown hue with the remainder thereof. *Stetinensis* has a median basal white streak on the forewings, which is wanting in the forewings of *ornatella*. *Stetinensis* has one more dorsal white streak than *ornatella* (the one nearest the apex of the forewings). The costal and dorsal spots have not relatively to each other the same position in the two species. In our judgment these are more than sufficient differences to base new species on; in addition thereto, *stetinensis* has a black spot at the apex of the wings, and *ornatella* has none. In what confusion are American Micro-Lepidopterists about all this? None whatever. The confusion, if it exists at all, is all in the Professor's own thoughts, and so it ought to be, after the tremendous head cudgeling he seems to have given himself about it. In fact, there ought to be a high court of Entomology to determine how much cudgeling of the head, or other punishment, an entomologist ought to suffer, who promulges such a disturbing element as this *brochure*, into waters as quiet and placid as these were before Professor Frey got into them with this *brochure*. But such cudgeling as the Professor gives himself is hardly adequate punishment for such riotous misconduct, entomologically speaking, as a man is guilty of when he makes *L. Argentinotella*, Clem., synonymous with *L. ulmella*, Chambers, or when he publishes new descriptions, and new names for half a dozen old insects, and makes confusion worse confounded by such comments as the Professor makes on *P. robiniella*, Clem. But, jesting apart. This little pamphlet has put more confusion into American micro-lepidopterology, than everything else put together that has ever been written on the subject. Mr. Stainton, somewhere in his edition of the Clemens' papers, states that he had determined not to publish anything on this subject until it had first passed through the hands of American Micro-Lepidopterists (or something to that effect, I can not now refer to the passage)—the value of the result of such a course is evident in Mr. Sainton's edition of the Clemens' papers; and the utter confusion which must result from a repetition of such *brochures* as this of Professor Frey, is equally as evident to all.

But we repeat, where is the confusion about *L. ornatella?* The whole history of it is given in Can. Ent., vol. iii., pp. 8, 54, 161, 182, and 205. It will there be seen that the larva was first known to Dr. Fitch, who, however, wrongfully attributed to it the mine of *L. robiniella*, Clem., and got the larva and mine confused with some species of *Anacampsis*, but he knew nothing of any *Lithocolletis ornatella*. That *was* confusion. Next Dr. Clemens incorrectly denied that there was any such mine, and determined properly that the larva was one of the flat *Lithocalletis* group, which he had not met with, and did not believe it existed on the locust, and that the mine was that of *L. robiniella*, Clem. Still I admit there was confusion, though less of it. Then I found on the leaves both the larva described by Dr. Fitch, each in its proper mine, and bred *L. ornatella* from one, and *L. robiniella* from the other. Thus, *L. ornatella* has been made known in all of its stages and habits. Where, then, is the confusion? And it has since been bred hundreds of times from other nearly allied plants, as well as from locust leaves.

The next locust miner is one of which Prof. Frey says little more than that he thinks he has found it (or its mines) among Mr. Bollo's material, viz.: *Lithocolletis robiniella*, Clem., subsequently described by Dr. Fitch, who also described as different species three micros much like it, all of which, however, Dr. Clemens, and I since him, after rearing multitudes from their mines in locust leaves (*Robinia pseudacacia* and *R. hispida*), both on the upper and under sides, and from *Desmodium* and allied genera have concluded to be new varieties of *L. robiniella*. Where, then, is the confusion about this species?

Depressaria robiniella, Packard, has never been considered doubtful. Neither has *Gelechia pseudaccaciella*, Cham. But little is known about these two species beyond the description. I have mentioned (Can. Ent., vol. iii., p. 87) a *Gelechia* like larvæ, dwelling in a tube of "frass," which it had constructed inside of the mines of L. *robiniella*, and which, as they are not the larvæ of *G. pseudaccaciella*, must be the larvæ of some new species; and I have occasionally observed *Galechia* larvæ swinging by thin little threads from locust leaves, which may be the same with the tube dwellers above mentioned; and, at all events, is the larvæ of an unknown species. *Gracilaria desmodifoliella* feeds on leaves of desmodium. Its life history is known, and there is no confusion about it. These are the only micro larvæ feeding on locust leaves yet made known (except the two next mentioned below), and although the imago has not been bred from either of the last named larvæ, yet there is no confusion about them, and the whole matter is understood, and the life history has been given of all the described species. The only other species which mine the leaves of the above mentioned plants are the *Parrectopa robiniella*, Clem., and *P. lespedezæfoliella*, Clem. Prof. Frey, by giving a new description and a new name, tries to throw some doubts over the question, whether an insect bred by him from locust leaves was the *P. robiniella*, Clem. But to every one familiar with the insect and its habits it is evidently the same, and *Lithocolletis gemmea*, Frey, can not supplant *Parrectopa robiniella*, Clem. There is not the slightest confusion about the insect, it is all about the name. Prof. Frey calls it *L. gemmea*, because of there being already one *L. robiniella*. If this insect is transferred to *Lithocolletis*, it must drop its specific name, *robiniella*, and Prof. Frey gives it a new one, viz.: *Lithocolletis gemmea*, Frey. If Dr. Clemens was right in creating a new genus for it, then the name that he gave it stands *Parrectopa robiniella*, Clem. If, as I think, the insect belongs to *Gracilaria*, then it is properly *Gracilaria robiniella*, Clem. To us it seems to have no very great relationship to *Lithocolletis*, for the following reasons: Dr. Clemens, as well as myself, was well acquainted with the mine, larvæ and imago, and it never occurred to either of us that it was with any propriety a *Lithocolletis*. Prof. Frey does not know the mine or larva. Dr. Clemens, seeing that it would not be placed in *Lithocolletis*, and that it did not belong in *Gracilaria*, as he seems to have restricted that genus, viz., to Zeller's section A of it, found no alternative but to erect a new genus, *Parrectopa*, for it—limiting *Gracilaria* to Zeller's section A, but receiving it, as it is generally understood (a not altogether homogenous genus which the time had not yet come to divide into other genera), I saw no impropriety in placing it in that genus, from many of the smaller species of which it does not differ generically. The same characters which show that it does not belong in *Lithocolletis*, show that it does belong in *Gracilaria* (unrestricted, though not in the *Gracilaria* of Dr. Clemens, that is section A of Zeller). Now, the fact is, that there is scarcely anything in common between this species (and *P. lespedezæfoliella* must go with it) and a true *Lithocolletis*. The mine is unlike that of any *Lithocolletis*, so is the larvæ, which is much more like that of a *Gracilaria*. It has a habit, like some *Gracilaria*, of retreating and hiding along the midriff of the leaf, so that the mine seems to be empty. It has the habit, like many *Gracilaria*, and like no *Lithocolletis* (unless Dr. Clemens' suggestion about *L. cratægella*, Clem., is correct) of leaving an old mine and making a new one in another leaf, and unlike all

Lithocolletis, except *L. ornatella*, Cham., and *L. helianthemella*, H. S., it leaves the mine to pupate, as do most species of *Gracilaria*. Then, when we come to the imago, the tuft on the vertex is much more like the long, loose scales, which slightly roughen the head of some species of *Gracilaria*, than it is like the erect tuft of *Lithocolletis*. Dr. Clemens was mistaken in the statement that it has no maxillary palpi; they are distinct, though small, as they are in some small species of *Gracilaria*, but both the maxillary and labial palpi differ in form and appearance from the palpi of *Lithocolletis*, being more like those of some small *Gracilaria*. The form of the head is more like *Gracilaria*, and, above all, the form and neuration of both the fore and hind wings *are those of a Gracilaria*, and not at all those of *Lithocolletis*. Hence, I think I am right in placing it in *Gracilaria*, as generally received, though perhaps not in *Gracilaria* as restricted by Dr. Clemens. Certainly it can never be properly placed in *Lithocolletis*. Where, then, is this wonderful confusion which the Professor tells the American Micro-Lepidopterists are in, and about which he gave his unfortunate head that terrible cudgeling? If it exists at all, it is only on the question whether the *name* of this last species (there is no trouble about the insect) should stand *Parrectopa robiniella*, Clem., or *Gracilaria robiniella*, Clem.—*Lithocolletis gemmea*, Frey, is *frayed* out.

The only remaining species mentioned by Prof. Frey in this genus, is *L. ænigmatella*, Frey, which seems to be not in all respects a *Lithocolletis*. I do not recognize any form known to me in this description.

The Professor then proceeds to the genus *Tischeria*, of which he thinks that he bred five species: ten from oak leaves, and one each from the apple, one from rubus (blackberry), and one from rose leaves. As to these, all we can say is, that, as to the oak-feeding *Tischeria*, the less said the better, until some one will study carefully the whole life history of this group. There is more confusion already about this group than about all the species of *Gracilaria* and *Lithocolletis* in the United States, although the described species do not amount to more than one tithe of either of the other genera. We think it very probable that entomology would be better off to-day, if Dr. Clemens, I, and Prof. Frey had entirely omitted all notice of the oak-feeding species of *Tischeria*. As to the species bred from the apple, rubus and rose, I believe that it is only one species, *T. Malifoliella*, Clem., under three names; the other two names, *T. ænea*, Frey, and *T. roseticala*, Frey, being added for the same species when feeding on the rubus and the rose. As early as 1871 (Can. Ent., vol. iii., p. 28), I mentioned the fact that *T. Malifoliella*, Clem., fed on the blackberry (*rubus villosus*) and the raspberry (*R. occidentalis*), as well as upon the apple, haw (*cratægus*), sweet-scented crab (*Pyrus coronaria*), and added the remark, it also probably fed on other *rosaceæ*, and now Prof. Frey has bred it from the rose. Are we to have a distinct name for an insect every time it is discovered feeding on a new plant? I have not seen the rose-feeding species, but we have seen no reason whatever for considering the species bred from the rose, as in any way specifically distinct from those bred from the apple, haw, and pear. *Lithocolletis cratægella*, Clem., affords a parallel case. Dr. Clemens observed that it fed on the haw (*cratægus*) and wild cherry (*Prunus serotina*), and I have recorded it from *cratægus*, *Pyrus coronaia*, quince (*cydonia vulgaris*) and the flowering or Japan quince (*Cydonia japonica*). I do not know but that it would be better to check the species-makers, by writing in advance, *Tischria cratægella*, *T. pyriella*, *L. pruniella*, *L. pyriella*, *L. cydoniella*, and *L. japonicella*, according to the plants they are bred from respectively, and calling them *phytophagic* varieties. No, that will not do, for they are not even varieties, otherwise than in their food.

Monograph of the Lamellibranchiata of the Cincinnati Group.
(By S. A. Miller.)

This class is known by several names. The oldest name, "*Bivalvia*,' of Linnæus, under the rules adopted by the English naturalists thirty years ago, takes precedence over all other names; but on account of its liability to mislead, as brachiopods are bivalves, it has not been very generally adopted. Cuvier called the class *Acephala*, and Lamarck called it *Conchifera*, and their names are adopted by many naturalists. Blainville, in 1814, described the class as *Lamellibranchiata*, and from its seeming appropriateness it has come into very general use in this country.

I have borrowed the descriptions of the class and the orders from British Palæozoic Rocks, by McCoy; but I have not attempted to put the genera in the families to which they belong. McCoy and Woodward have placed the genus *Ambonychia* in the family *Aviculidæ*, and I presume for the same reasons they would put *Megambonia* and *Anomalodonta* in that family. But these genera seem to me to have a closer affinity with *Myalina* and other genera belonging to the *Mytilidæ*, than they have with the *Aviculidæ*. One can not help being struck with the resemblance between the hinge line of the *Myalina subquadrata* and that of the *Anomalodonta gigantea*. It is quite probable, however, that these equivalve shells, with a large byssus, belong to neither of these families, but to some other family. The fact is, that, until quite recently, but little attention was paid to the internal structure of Lower Silurian shells belonging to this class, and consequently but little was known of their family relations. The hinge lines of the *Avicula*, *Ambonychia*, *Cypricardites* and *Tellinomya*, have been known for only a few years; the hinge line of *Anodontopsis*, if it be the hinge line of that genus, was first figured in the Ohio Paleontology, in 1873; and within the present year I have figured and described, for the first time, the hinge lines of the *Anomalodonta*, *Modiolopsis* and *Cycloconcha*; while we are yet wholly ignorant of the hinge lines and internal structure of the *Orthonota*, *Cleidophorus*, and other genera, and numerous species, belonging to this class, and found within the Cincinnati Group.

For these reasons [and the further fact that I have not had the time to devote to the study of the generic affinities of these shells, necessary to trace out their relations, or to throw any particular light on the subject], I have omitted the arrangement of the genera into families, in this monograph. It is a matter of very grave doubt whether any person is justified in describing a species, when he finds it necessary to follow the generic name with an interrogation point, and especially from a mere cast, and there can be no doubt that he is wholly inexcusable for attempting to arrange genera into families without full confidence in the correctness of the classification.

I have described one new genus (*Cycloconcha*), and two new species, for this monograph, and have omitted to include any species about the existence of which, in the Cincinnati Group, I entertain any doubt. It is not a difficult thing to find casts that we are unable to specifically identify, but to give each of them a name, or to call them by the names of the casts that have been figured from New York, Canada, or elsewhere, from a slight resemblance merely to the engravings, would not add anything to our knowledge of the science, but would rather be a stumbling block in the way of advancement, consequently, I have omitted them. It is an indisputable fact, however, that several new species will be added to this list, either by new descriptions or by future identification with those already described elsewhere.

Class Lamellibranchiata—(Blainville).

This class has two shelly valves, placed at right angles to their position in the *Palliobranchiata*, one valve being applied to each side;

they are connected by a ligament, within which is an elastic substance, termed cartilage, which forces the valves open; the valves are closed in the lower groups by one central adductor muscle, and in the higher types by two or more. *Respiration* (as the name implies) is effected by lamellar branchiæ, or gills, which are four, crescent shaped, and attached to the inside of the mantle; one pair on each side of the visceral mass. Each valve is lined by a lobe of the mantle, and the attachments of the muscular fibers, for retracting its edges, form the pallial scar in the shell; in the low types the lobes are open and disconnected, as in the *Palliobranchs*, and there is little or no foot; in the higher types the edges of the two lobes are united posteriorly, and produced into two tubular siphons; one branchial, through which the water enters to the gills, and carrying nutrient particles to the mouth; the other anal, through which the impure water constantly flows out, the currents in each case produced by vibratile ciliæ; the attachments of the line of muscular fibers for retracting the siphon form the "pallial sinus" in the shell of such as have the siphons. The animal is without head or cephalic organs of sense; the mouth is at the anterior end, without organs of mastication, having two strap-shaped, sensitive tentacles on each side, the upper pair of which correspond, on a reduced scale, with the spiral arms of the *Brachiopoda;* the lower pair (which equal the upper in size) are analogous to the transverse brachial, fringed part below the mouth in the same; a short œsophagus leads into a pear-shaped stomach, leading to a convoluted intestine, the straight terminal portion, or rectum, perforating the heart and terminating at the base of the anal siphon, or over the posterior adductor. The liver is a large follicular mass, enveloping the stomach; a glandular mass, partially surrounding the rectum, is called *kidney,* by Owen, from uric acid having been found in it, but is marked *ovary* by Milne Edwards (both agree that the ovary in the female and testis in the male surrounds the intestine). The foot, when it exists, is a symmetrical, fleshy, extensile organ, developed from the ventral aspect of the body; the enveloping muscular fibers are transverse, the action of which protrudes the foot, and longitudinal, the action of which retracts it. In the lower bivalves (*monomyaria*), the heart is of a single auricle, and one ventricle, perforated by the rectum; in the higher groups (*Dimyaria*), the veins from the gills open into two auricles, which open into one fusiform ventricle, perforated by the intestine (in *Arca* the ventricle is double). An artery from each end of the ventricle distributes the blood. *Nerves*—in the *monomyaria* the principal ganglion is on the ventral convex edge of the adductor, to which it sends branches, as well as to the gills and mantle; two yellow filaments extend to the mouth, where another pair of ganglia supply the tentacles, and give off a delicate ring round the œsophagus. In the *Dimyaria* the main pair of ganglia (branchial) are at the under edge of the posterior adductor, sending, as before, cords to the supra-œsophageal ganglia, between the mouth and the anterior adductor; numerous other small ganglia are developed in various positions. *Hearing*—*Cyclas* has at the anterior part of the labial tentacles a cavity, with a cretaceous, oscillating nucleus, considered by Dr. Siebold to be the *ear*. *Sight*—*Pecten* has numerous small eyes round the edge of the mantle, but most of the types are blind. *Development*—the spermatic filaments discharged from the males are drawn in by the branchial currents of the females. The young, or embryo, of the dimyarian genus *Anodon*, have only a single adductor, as in the *monomyaria*, and possess a byssus. The shells are extra-vascular, of an external cellular or fibrous and a thin internal nacreous layer, forming the hinge teeth.

This class is divided into three orders: 1st. *Pleuroconcha*; 2d. *Isedrolotila*; 3d. *Macrotrachia*.

Order *Pleuroconcha*—(D'Orb).

Shell inequivalve, unsymmetrical. Animal unsymmetrical; lobes of the mantle disunited, never forming siphonal tubes; pallial impression consequently entire. Natural position—resting on the side.

They are fixed to foreign bodies, either by a byssus or by the substance of the lower valve; the shells in the latter case being remarkable for the irregularity of their growth.

This order contains the following families: 1st. *Anomiidæ*; 2d. *Ostreidæ*; 3d. *Etheridæ*; 4th. *Chamidæ*; 5th. *Spondylidæ*; 6th. *Pectinidæ*; 7th. *Aviculidæ*, etc.

The family *Aviculidæ* (wing shells) is described as follows:

Shell inequivalve, very oblique, resting on the smaller (right) valve, and attached by a byssus; epidermis indistinct; outer layer prismatic, cellular; interior, nacreous; posterior muscular impression large, subcentral, anterior small, within the umbo; pallial line irregularly dotted; hinge line straight, elongated; umbones anterior, eared, the posterior ear wing-like; cartilage contained in one or several grooves; hinge edentulous, or obscurely toothed.

The genus *Avicula* belongs to this family.

Order, *Isedrolotila*—(McCoy).

Shell equivalve, symmetrical; animal, having the mantle usually open throughout, not forming siphons; the pallial impression always simple and entire; two or more muscular impressions in each valve.

The order contains the following families: 1. *Limidæ*; 2. *Mytilidæ* 3. *Arcadæ*; 4. *Nuculidæ*; 5. *Trigoniidæ*; 6. *Unionidæ*; 7. *Lucinidæ*; 8. *Cyclasidæ*; 9. *Cyprinidæ*; 10. *Astartidæ*; 11. *Tridacnidæ*; 12. *Cardiidæ, etc,*

The family *Mytilidæ* is described as follows: Shell elongate, oval, narrow in front, widening posteriorly, more or less closed (equivalve, pallial impression entire), cartilage very long, marginal or nearly so, supported by an internal plate nearly parallel with the hinge line; beaks close to the anterior end or terminal; two or three muscular impressions in each valve. *Animal:* mantle more or less open; gills fringed or entire; mouth with appendages; foot narrow, tongue-shaped, with a fibrous byssus at its base, to attach the shell to foreign bodies, having a small sinus in the anterior part of the ventral margin, from which an oblique, impressed furrow extends toward the beak, defining the anterior lobe.

The genera *Modiolopsis, Cypricardites,* etc., belong to this family.

The family *Trigonidæ* is described as follows: Shell equivalve, close, trigonal, with the umbones directed posteriorly; ligament external; interior nacreous; hinge teeth few, diverging; pallial line simple.

The genus *Lyrodesma* belongs to this family.

Genus *Avicula*, Klein—(Bruguire).

[Etym.—*Avicula*, a little bird.]

Shell obliquely oval, very inequivalve; right valve with a byssal sinus beneath the anterior ear; cartilage pit single, oblique; hinge with one or two small cardinal teeth, and an elongated posterior tooth, often obsolete; posterior muscular impression (adductor and pedal) large, sub-central; anterior (pedal scar) small, umbonal.

Avicula demissa—(Conrad, 1842).

Obliquely subovate, compressed, extended posteriorly into a broad, triangular wing; anterior wing short, obtuse; surface marked by close, sharp, imbricating, lamellose striæ; posterior wing extending beyond the line of the posterior extremity of the shell; anterior and posterior margins nearly parallel, and but slightly oblique.

It is characterized by the sharp elevated concentric striæ, which are crowded together on the posterior wing, and at its junction with the body of the shell.

This species has not been observed by me below about 200 feet above low water-mark. From this point it is found throughout the blue limestone to the Upper Silurian, into which it probably passes. The convex valve is a common fossil, and is found showing the interior side about as frequently as the exterior. A specimen showing both valves is, however, quite rare. It is very much larger in the upper part of the Cincinnati Group than it is in the lower part or about the city of Cincinnati. Specimens are found about Richmond, Indiana, four inches or more in length, and the same may be said of it at other places.

Avicula insueta—(Conrad, 1842).

Shell obliquely subrhomboidal, depressed, convex; hinge line extended; anterior wing short, obtuse or rounded; posterior wing triangular, acute, extending a little beyond the margin of the shell; surface marked by unequal concentric striæ and stronger wrinkles, and longitudinally, along the middle of the shell, by obscure radii.

It is found at all elevations about Cincinnati higher than 200 feet above low water-mark. Having a frail shell; good specimens are not common.

Genus *Modiolopsis*—(Hall, 1847).

Character, equivalve, inequilateral, elongated, becoming broader posteriorly; umbones near the anterior extremity, which is marked by a single, strong, muscular impression, as in *modiola*. A sinus often extends from the anterior side of the umbones obliquely backward, leaving the anterior portion separated as a kind of lobe. Surface marked by fine concentric striæ; shell thin.

One of the most prominent characters is the strong muscular impression, which is close to the anterior margin: this is often visible in the shell, forming a little circumscribed elevation, and more conspicuous in the cast, where it is usually well preserved. There is often a slight contraction or sinus below, or posterior to, the umbones, but this is not always conspicuous. The shells of this genus are, for the most part, smooth, or marked only by fine concentric lines, indicating the laminæ of the shell, and they are generally free from angular ridges.

Modiolopsis modiolaris—(Conrad).

[See page 149, April No. of this Journal.]

Modiolopsis Versaillesensis—(S. A. Miller.)

[See page 150, April No. of this Journal.]

Modiolopsis anodontoides—(CONRAD).

General figure subelliptical, very convex; beak elevated, with a strong angular ridge extending to the posterior basal margin; cardinal margin nearly straight; posterior extremity obliquely truncated; base contracted just below or a little posterior to the beak; surface marked by strong concentric striæ; length a little more than twice the height. It is readily recognized by its great umbonical elevation, and the prominent oblique carina extending from the beak to the posterior basal extremity.

This species was placed by Conrad in the genus *Cypricardites*, and removed by Hall into the genus *Modiolopsis*, where I have left it, for want of knowing the hinge line and internal structure. It is most likely, however, that it belongs to neither of these genera.

It is found opposite the foot of Fifth street, in Kentucky, and opposite the mouth of the Little Miami river. Its range, so far as is known, is limited between low water-mark and 200 feet above. It is not common, by any means.

Modiolopsis truncatus—(HALL, 1847).

Oblique, transverse, subtrapezoidal; the cardinal and basal margins diverging from the anterior extremity, convex; beaks near the anterior extremity, with an obscure elevated ridge extending obliquely to the base; posterior extremity obliquely truncate; muscular impression very distinct, a little in advance of the beaks, and at the anterior extremity, in the cast, projecting beyond the margin.

It differs from *M. modiolaris*, in that it is proportionally broader; the beaks are closer to the anterior extremity, while the muscular impression seems to be placed upon the very margin of the shell.

The shell of this species is unknown.

It is found at the quarries back of Cincinnati, from 300 to 450 feet above low water-mark. Its exact range is unknown, and good casts are very rare.

Modiolopsis terminalis—(HALL, 1847).

Subcylindrical, elongated, very gradually expanding from the anterior extremity; beaks subacute, near the anterior extremity; surface smooth, or with fine concentric striæ.

In the perfect shell the beaks extend nearly, or quite, as far as the line of the anterior margin.

This fossil has only been found as a cast, and it is by no means certain that it belongs to the genus *Modiolopsis.* It is very scarce, a good specimen ornamenting but few cabinets. It is occasionally found at the quarries back of Cincinnati, from 300 to 450 feet above low water-mark.

Genus *Cypricardites*—(Conrad).

[See page 147, April No. of this Journal.]

Cypricardites Hainesi—(S. A. Miller.)

[See page 147, April No. of this Journal.]

Since this description was written, I have spent two days at Richmond, Indiana, and succeeded in finding valves with the cardinal teeth preserved. There are two cardinal teeth (at *t*, Fig. 13), rather obtuse, width a little greater than the length.

Cypricardites Sterlingensis—(Meek and Worthen).

Shell obliquely rhomboidal, or rhombic subcordate, being cordate in outline as seen in an anterior or posterior view, and more or less rhomboidal as seen from either side. Posterior margin very obliquely truncated, with a long slope; posterior basal extremity produced and very narrowly rounded; basal margin ascending forward with a moderately convex curve, and rounding upward into the very short, more or less rounded, anterior margin. Hinge line short, ranging at an angle of about 45 to 50 degrees from the umbonal axis. Umbonal ridges very prominent, or subangular, from the posterior side of the beaks obliquely backward and downward to the posterior basal extremity; area above and behind this ridge, flattened in each valve; and that below and in front of it more or less convex. Surface unknown. Posterior muscular impression large, nearly circular, faintly marked, and placed near the middle of the posterior truncated margin. Anterior muscular scar smaller, more oval, and placed nearly against the anterior margin.

Length, measuring obliquely from the most prominent part of the front to the posterior basal extremity, 2.14 inches; height at right angles to the hinge, 1.75 inches; convexity, 1.25 inches.

Found in the upper part of the Cincinnati Group, at Richmond, Indiana.

Cypricardites? carinata—(Meek).

Shell small, rhombic-cordate, very convex along the oblique umbonal slopes, posterior margin apparently obliquely truncated; posterior basal extremity more or less angular in outline; basal margin rounding and ascending obliquely forward from the posterior basal angle; anterior side extremely short, or with its margin descending and curving backward into the base from immediately in front of the beaks; hinge line short, and a little inflected, so as to form a kind of small area or escutcheon behind the beaks; beaks prominent, rather oblique, nearly terminal, strongly incurved or subspiral, and distinctly compressed anterio-posteriorly, so as to be sharply keeled on top, the keel being continued as a less angular umbonal ridge backward and downward to the posterior basal extremity; flanks in front of the umbonal ridge evenly convex, while the space above and behind it, near the beaks, is somewhat concave. Surface only showing obscure traces of lines of growth. (Hinge and interior unknown.)

Length, measuring obliquely from the posterior basal angle to the most prominent part of the umbonal keels, 0·65 inch; anterio-posterior diameter, measuring parallel to the hinge line (the specimen being defective behind), 0·40 inch; convexity of the united valves, 0·50 inch; length of hinge about 0·30 inch.

Found near the top of the hills back of Cincinnati. Range unknown.

Sedgwickia? fragilis—(Meek).

Shell rather small, apparently very thin, longitudinally oblong or suboval, rather distinctly convex along the umbonal slopes from the beaks toward the posterior basal margin, and down near the anterior side, while just under the beaks a rather strongly marked impression descends, widening and deepening as it approaches the base; basal margin subparallel in its general outline to the dorsal, but diverging more or less posteriorly, where it is most prominent, while it is rather distinctly sinuous toward the front; posterior margin wider than the anterior, and more or less truncated; anterior extremity very short, and rounded, or somewhat truncated; hinge line straight, and shorter than the entire length of the valves, apparently very slightly inflected behind the beaks, which are raised a little above the cardinal margin, incurved, contiguous, flattened on the outer sides, and placed near the anterior end, with a slight forward inclination. Surface ornamented with moderately distinct lines, and irregular minute wrinkles of growth.

Found at the quarries back of Cincinnati, about 350 feet above low water-mark. Range unknown.

Sedgwickia? compressa—(Meek).

Shell longitudinally oval, compressed, about one fourth longer than high, cuneate posteriorly, and more convex in the central and anterior regions, with a slight concavity descending from the beak to the base of each valve; posterior margin regularly rounded; base straight, and parallel to the cardinal margin in the middle, and rounding up to the anterior and posterior margins; anterior side short, rounded or somewhat truncated, but apparently most prominent below; hinge line shorter than the valves, straight behind the beaks, but rounding into the posterior margin at the extremity, erect behind, with some appearance of a narrow space for an external ligament farther forward; beaks about one fourth the length of the valves from the anterior margin, raised a little above the cardinal margin, nearly contiguous, but not much incurved. Surface of a cast, that seems to be a little weathered or smoothed by attrition, showing obscure marks of growth. Length, 0·77 inch; height, 0·59 inch; convexity, 0·29 inch.

Found at the quarries back of Cincinnati, about 350 feet above low water-mark. Range unknown.

Sedgwickia (Grammysia ?) Neglecta—(Meek).

Shell transversely ovate, about one third longer than high, rather distinctly compressed, most convex and most elevated in the central and umbonal regions, and compressed-cuneate behind; anterior margin rounding from the lower end of the lunule into the base, which forms a nearly semi-oval curve, its most prominent part being near the middle; cardinal margin apparently straight, and declining posteriorly from the beaks; posterior margin rather narrowly rounded; beaks moderately prominent, and scarcely one third the length of the valves from the anterior margin. Surface ornamented with regular, distinct, but not very prominent concentric costæ, that become suddenly obsolete on the posterior third of the valves. Lunule narrow, but sharply defined.

Length, about 1·04 inch; height, 0·67 inch; convexity about 0·35 inch.

Found in the upper part of the Cincinnati Group, in Clinton county.

Cardiomorpha?? obliquata—(Meek).

Shell small, rhombic-cordate, very convex, higher than long; posterior margin sloping rather abruptly, and subtruncate, or a little convex in outline from the posterior extremity of the hinge to the posterior basal extremity, which is more or less angular, or narrowly rounded; basal margin short, nearly straight or a little convex from the posterior basal extremity to the front; anterior margin short or truncated from immediately in front of the beaks obliquely downward and backward to the base, which it joins at an obtuse, slightly rounded angle; hinge line very short, ranging at an angle of about fifty degrees to the umbonal axis, and apparently having its margins a little inflected behind the beaks; beaks very prominent, oblique, nearly or quite terminal, and strongly incurved; posterior umbonal slopes subangular near the points of the beaks, but becoming rounded below, while the dorsal region between this and the hinge is a little concave; anterior umbonal slopes forming a kind of ridge, that extends at something less than a right angle to the hinge to the anterior basal margin, the anterior side, thus circumscribed, being somewhat flattened, and, as seen from the front, presenting a cordate outline. Surface ornamented with small, very regular, simple, concentric costæ, that seem to be obsolete on the anterior and posterior portions of the valves. (Hinge and interior unknown).

Length parallel to the cardinal margin, about 0.45 inch; height, at right angles to hinge, to the tops of the beaks, about 0.45 inch; length, measuring from the points of the beaks obliquely, to the posterior basal extremity, 0.57 inch; convexity, 0.39 inch.

Found near the top of the hills back of Cincinnati. Range unknown.

Genus *Orthonota*—(Conrad, 1841).

Shell elongated, margins parallel, umbones anterior, back plaited.

Orthonota parallela—(Hall, 1847).

Shell extremely elongated and very narrow; anterior extremity rounded, and contracted just forward of the beaks; cardinal margin straight or gently arched; posterior extremity rounded, broader than the anterior; basal margin slightly arcuate; beaks near the anterior extremity having an obscure carina, extending obliquely toward, but not reaching, the posterior basal margin; surface marked by fine concentric striæ, and a few oblique, strong wrinkles, along the dorsal margin.

Width one third the length. In specimens embedded in shale, and much compressed, the surface is regularly convex, and the oblique, elevated carina, becomes obsolete. The cast is smooth, with scarcely any evidence of the oblique folds on the cardinal margin.

This fossil is known only as a cast, which is by no means abundant. It is found at the quarries about Cincinnati, but its range is not known.

Orthonota contracta—(HALL, 1847).

Subcylindrical, slightly arcuated; beaks distinct, acute, with a prominent oblique carina extending toward the posterior basal margin, which is arcuated, and the shell much contracted below and posterior to the beaks; dorsal margin broad, rounded, the valves strongly marked by oblique folds.

The base is arcuate, and distinctly contracted or sinuate a little behind the beaks. It differs from *O. parallela*, in having more acute and distinct beaks, with cardinal margin broader.

This fossil is known only as a cast. It is scarce at the quarries, and its range is unknown.

Orthonota pholadis—(CONRAD, 1838).

Shell profoundly elongated, ventricose; dorsal and basal margins parallel; posterior side rugose, or with short undulations near the dorsal margin. Length, $1\frac{3}{4}$ inches.

The form believed to belong to this species is quite rare at the quarries back of Cincinnati, and is found only as a subcylindrical cast. Its range is not known.

Genus *Cleidophorus*—(HALL, 1847).

[*Cleidophorus*, in allusion to the clavicle in each valve, anterior to the beak].

Shell equivalve, inequilateral; hinge without teeth or crenulations; surface (particularly in casts), marked by an oblique linear depression, extending from the anterior cardinal margin toward the base, indicating the place of the clavicle; surface concentrically striated.

Cleidophorus fabula—(HALL, 1845).

Shell minute, or very small, transversely subelliptic, moderately convex; extremities narrowly rounded, the anterior end being narrower than the posterior; basal margin forming a broad semi-elliptic curve; beaks rather depressed, slightly tumid, and placed a little in advance of the middle; dorsal margin sloping gently from the beaks, the anterior slope being rather less gradual than the other, and, in the cast, a little concave in front of the beaks. Anterior muscular impressions distinctly defined by the internal ridge, which leaves a rather deep furrow just in advance of each beak in casts of the interior.

Length of a medium sized specimen, 0.06 inch; height, 0.03 inch; convexity about 0.02 inch.

It is found from 300 feet above low water-mark, at Cincinnati, to the top of the Cincinnati Group. It attains a much larger size in the upper part of the Group at Versailles, Indiana, than it does in the hills about Cincinnati.

Genus *Ambonychia*—(HALL).

[See page 14, January No. of this Journal.]

Ambonychia radiata—(HALL).

[See page 15, January No. of this Journal.]

Ambonychia bellistriata—(HALL).

[See page 14, January No. of this Journal.]

Ambonychia costata—(JAMES).

[See page 15, January No. of this Journal.]

Genus *Anomalodonta*—(S. A. MILLER).

[See page 16, January No. of this Journal.]

Anomalodonta gigantea—(S. A. MILLER).

[See page 17, January No. of this Journal.]

Anomalodonta alata—(MEEK, 1872).

Shell attaining a moderately large size, subtrigonal in general outline, compressed posterio-dorsally, and more convex in the umbonal and anterio-central regions; umbonal slopes ranging at an angle of about fifty degrees below the hinge line, and broadly rounded; hinge line straight, very nearly or quite equaling the greatest anterio-posterior diameter of the valves, and ranging nearly at right angles to the anterior side of the same; posterior alation very large, not separated from the swell of the umbonal and central regions by any defined sulcus, slightly rounded at its immediate extremity above; posterior margin faintly sinuous a little below its intersection with the hinge margin above, thence sloping forward and downward, and finally rounding into the regularly rounded base; anterior side more or less concave, and nearly vertical above, but rounding regularly into the base below; beaks terminal, rather pointed, rising little above the hinge line, and directed a little obliquely upward and forward, with more or less inward curvature.

Surface marked by 24 to 28 simple, strong, radiating costæ to each valve, that are nearly equal in breadth to the furrows between; those on the central portions of the valves passing nearly straight from the beaks obliquely to the posterior basal margins, those on the anterior side curving more or less forward below, and those near the cardinal margin curving a little upward behind. Crossing all of these costæ and the furrows between, are numerous fine crowded lines, and at regular distant intervals, a few strongly defined imbricating marks of growth that curve parallel to the basal and posterior margins.

Height, 2.30 inches; breadth, 2.20 inches; convexity, about 0.80 inch. Found near Freeport, Warren County, and in Clinton County, Ohio.

Anomalodonta Casei—(Meek and Worthen).

Shell trigonal, compressed, subequivalve, extremely inequilateral, posterior side long, compressed and strongly alate; the wing very large, produced, pointed, and not separated from the alate posterior margin by a distinctly defined sinus; margin below the wing sloping obliquely forward to the basal angle; cardinal margin the longest part of the shell, straight, and much compressed from immediately behind the beaks; anterior side truncated nearly vertically from the beaks, about half way down the front, thence sloping slightly backward to the basal angle; basal margin produced downward, and terminating in a distinct angle, slightly in advance of the middle. Umbonal slopes very prominent, angular, or sometimes apparently bicarinate, straight, and extending from the beaks, near the anterior margin, to the most prominent part of the base, ranging at an angle of about sixty-five degrees below the horizon of the hinge line, and provided with a longitudinal sulcus below the middle of the valves. Beaks straight, rising a little above the cardinal margin, and quite terminal. Surface ornamented with distinct, irregular, alternately larger and smaller thread-like radiating striæ, with less distinct concentric lines, and a few distinct, stronger marks of growth, which sometimes form prominent, imbricating subspinous projections on the umbonal angle.

Length, 2 inches; height, 1·73 inches; convexity, 0·64 inch.

Found in the upper part of the Cincinnati Group, at Richmond, Indiana.

Genus *Megambonia*—(Hall, 1859).

Shell equivalve or subequivalve, inequilateral, subovoid, usually very gibbous in the middle and toward the umbones; anterior side often lobed or auriculate, a strong muscular impression occupying a considerable portion of this part of the shell; posterior cardinal margin expanded, more or less compressed and frequently alate; hinge line crenulated on the anterior end; teeth numerous.

Surface marked by concentric laminæ of growth, and often by fine radiating striæ.

The entire structure of the hinge line is unknown; and the grouping of the species has been mainly determined by external form and marking and the large anterior muscular scar, which is a conspicuous feature in most of the species.

Megambonia Jamesi—(Meek, 1872).

Shell rather large, a little obliquely subovate in general form, rather convex, the most gibbous part being somewhat above and in front of the middle, more or less abruptly cuneate posteriorly and below; basal outline regularly rounded; posterior margin rounding into the base, and ascending with a convex curve and forward inclination to the posterior extremity of the hinge, which is not in the slightest degree alate behind; anterior margin rounding into the base below, and slightly sinuous under the lobe-like protuberance or rudimentary wing above, which is convex, slightly more prominent than the margin below, and defined from the swell of the umbonal regions on each side, by an oblique sulcus extending to the hinge margin in front of each beak; hinge equaling about two thirds the anterio-posterior diameter of the valves; beaks rather prominent, or rising distinctly above the hinge line, but slightly oblique, and distinctly incurved; umbonal slopes broadly rounded; longer axis of the valves moderately oblique to the hinge line. Surface ornamented by very regular, rounded, simple, and depressed radiating costæ, a little wider than the furrows between, and numbering about five in a space of 0.30 inch, near the middle of the lower margin.

Height about 2.50 inches; anterio-posterior diameter, 2.16 inches; convexity, 1.50 inch.

Described from a single specimen—a cast of the exterior, with portions of the ventral and anterior ventral margins broken away, and the right beak projecting above the left from displacement. It showed distinct indications of a well defined, moderately wide cardinal area, widest under the beaks, and narrowing to the extremities of the hinge.

Found at Cincinnati, about 350 feet above low water-mark.

Genus *Lyrodesma*—(Conrad, 1841).

Equivalve, inequilateral; trigonia shaped, elongated, posterior area striated, hinge with from five to nine diverging prominent cardinal teeth, transversely striated; ligament external.

Lyrodesma plana—(Conrad, 1841).

Subrhomboidal, compressed; posterior margin widely and obtusely truncated; posterior basal margin rectilinear and striated; extremity rounded; cardinal process semi-circular, and marked by eight diverging teeth.

This fossil is found at the quarries back of Cincinnati. It is quite rare, and its range is unknown.

Lyrodesma Cincinnatiensis—(Hall, 1871).

Shell small, subrhomboidal in outline, and obtusely pointed at the posterio-basal angle; valves moderately convex with a subangular umbonal ridge and narrow cardinal slope; anterior end rounded and passing into the more broadly rounded basal line; posterior end oblique, pointed below; hinge line short; beak very small. Hinge plate occupied by six angular, crenulated, radiating teeth, which, diverging from beneath the beak, are strongly arched upward between their origin and extremities; crenulations minute, but very distinct; muscular impressions and pallial line not observed.

Differs from *L. postriata* and *L. plana* in the much shorter form and in number of teeth.

Found at different places, within 300 feet of low water-mark. It is a rare fossil, and the extent of its range is not known.

Genus *Anodontopsis*—(McCoy).

Equivalve, inequilateral, compressed; general form rotundato-quadrate or subtrigonal; posterior side wide; round, or obliquely subtruncate, anterior end slightly contracted in front of the beak; beaks small, prominent, nearer to the anterior than the posterior end; hinge line shorter than the shell, with a posterior, long, slender, lateral tooth or cartilage plate, extending just below it (double in the right valves), and another similar but shorter one in front of the beaks; anterior and posterior muscular impressions, simple, ovate, the latter longer and stronger than the anterior; occasionally a slight clavicular ridge extends from in front of the beak behind the anterior adductor impression, leaving a furrow in the cast; pallial impression entire; (occasionally one small cardinal tooth beneath the beak); surface smooth or concentrically lined.

Anodontopsis (?) unionoides—(MEEK).

Shell thin, subovate, rather compressed, most convex slightly above and in advance of the middle; anterior margin regularly rounded; basal margin forming a broad semi-elliptic curve, or nearly straight along the middle; posterior margin sloping from the posterior extremity of the hinge above, and rounded into the base below; hinge line straight, apparently rather short; beaks depressed nearly to the hinge margin, small, and placed between one fourth and one fifth the length of the valves from the anterior end. Surface showing only a few distant subimbricating marks of growth.

Length, 1.75 inches; height, 1.14 inches; convexity, 0.63 inch.

Found about 350 feet above low water-mark, at Cincinnati. Range not known. Very rare.

Some of the casts that are usually supposed to belong to the genus *Modiolopsis* probably belong to this species. I do not believe, however, that it belongs either to the genus *Anodontopsis* or *Modiolopsis*; indeed, I think it is very far removed, at least from the former, but as I don't know into what genus it should be placed, I have left it where Prof. Meek has left it.

Anodontopsis? Milleri—(MEEK).

Shell ovate, rather compressed or only moderately convex, the greatest convexity being a little above and slightly in advance of the middle, extremities more or less narrowly rounded, basal margin longitudinally semi-elliptic in outline, the most prominent part being near the middle; cardinal margin sloping from the beaks at an angle of 130 to 135 degrees, and rounding into the lateral margins; beaks only moderately prominent, somewhat obtuse, and not very convex, placed more than one third the length of the valves from the anterior end. Surface smooth, or only with obscure lines of growth.

Length of a medium sized adult specimen, 0·83 inch; height. 0·59 inch; convexity, 0·30 to 33 inches.

The hinge may be characterized as having one rather well defined, subtrigonal, or somewhat obliquely extended cardinal tooth under the beak of the right valve, and a corresponding pit under the beak of the left valve, with sometimes a slight prominence or rudimentary cardinal tooth just in advance of this pit; while of posterior lateral teeth there is in the right valve one long tooth ranging parallel to the cardinal margin, with a parallel furrow above and below it, for the reception of two long posterior laterals in the left valve, the lower one of which is more prominent, and the upper merely linear or rudimentary. The furrow between these two posterior lateral teeth of the left valve is well defined, and receives the corresponding tooth of the other valve. Below the lower of these furrows, on the posterior side of the right valve, there is a very slight marginal ridge, that may sometimes assume the character of a second posterior lateral, but it is most prominent anteriorly, where it connects with the cardinal tooth, of which it seems rather to be an oblique posterior prolongation than a distinct tooth. On the anterior side, there is one shorter anterior lateral tooth in the right valve, also ranging parallel to the hinge margin, and above and below this a little furrow for the reception of two small anterior laterals in the left valve, which receive between them that of the right valve.

The pallial line is certainly simple, and the muscular impressions well defined, the posterior one being larger than the other, and provided with a small accessory scar above, just under the posterior ends of the posterior lateral teeth. The ligament or cartilage was probably small and internal, as there are no traces of an external ligament to be seen, the valves fitting close all along the hinge margin. No lunule or escutcheon is to be seen in any of the specimens.

Found about 300 feet below the Upper Silurian rocks, at Versailles, Indiana.

Genus *Tellinomya*—(Hall, 1847).

[From *Tellini* and *Mya*, from the form of the shell.]

Shell equivalve, equilateral or subequilateral, closed, smooth, or marked by lines of growth; ligament external; hinge line curved, sometimes subangular, with a continuous series of small curved transverse teeth, which diminish from the extremities to the beak, beneath which they are much smaller; muscular impressions double, two anterior and two posterior, one large and strongly impressed, the other smaller, lying above and between the larger one and the hinge line; pallial impression simple.

In the larger species known, the hinge line is only slightly arcuate; while among the other species we find many variations in the curvature, and it sometimes becomes distinctly angular, as in *T. cuneata.*

In some species the teeth on either side of the beak curve outward from it, and in others inward, toward the beak on both sides. The teeth are often very minute immediately beneath the beaks.

The shells of this genus vary from elliptical to ovate and subtriangular forms, many of them being contracted on the posterior side; they are usually of moderate thickness, though one species is very thick and strong. Some of the species have a distinctly impressed lunule. The lesser muscular impression is often a small pit, placed directly beneath the hinge line, and between it and the large muscular impression. The beaks are usually of medium size, pointed, rarely ventricose, approximate or in contact, never sub-spiral.

The relations of this shell are among the *Arcadæ* and approximate to the *Nucula* in their general character, and to which genus they have usually been referred. They differ from that genus, however, in the absence of the ligamentary pit beneath the beak, and in the presence of an external ligament and double muscular impressions.

Tellinomya (?) obliqua—(Hall, 1845) as redefined by Meek.

Shell very small, compressed, subcircular, approaching subquadrangular; height and breadth about equal; anterior margin short and rounding into the rounded basal margin; posterior margin subtruncated, or more or less rounded; beaks elevated, nearer the anterior margin; dorsal margin sloping from the beaks, the anterior slope being the more abrupt, and the margin behind the beaks straighter, more compressed and sharper; surface smooth; internal casts showing the muscular impressions to be, comparatively, rather distinct. Hinge unknown.

Length of a medium sized specimen, 0.06 inch; height slightly less; convexity, 0.03 inch. It varies, however, from less than half this size to more than double as large.

It is found throughout the Cincinnati Group, from low water-mark in the Ohio river to the Upper Silurian rocks. It should be regarded as a common fossil.

Tellinomya pectunculoides—(Hall).

Shell small, sub-circular in outline, with the posterior end slightly prolonged below the middle, giving a little obliquity to the shell; posterior cardinal border obliquely sloping to the point of greatest extension; anterior and basal borders regularly rounded; beaks small;

general surface of the valves depressed convex. Hinge plate strongly arcuate, more abruptly curving in the middle, occupied by ten or twelve teeth on each side of the center, those in the middle being nearly straight, becoming more and more bent and angular toward the extremities; muscular impressions large and distinct; pallial line strongly marked, situated considerably within the border of the valve.

Surface characters of the valves not observed.

Tellinomya Hilli—(S. A. Miller).

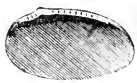

Fig. 20. *Tellinomya Hilli.* Internal part of a valve slightly magnified.

Shell somewhat oval in outline, the posterior end prolonged, with the cardinal border nearly straight, until it bends somewhat circularly to the point of greatest extension; anterior end quite regularly rounded; basal margin forming a semi-elliptic curve; beaks near the anterior end moderately prominent, greatest convexity immediately behind the beaks; surface smooth. Hinge line occupied by three small teeth anterior to the beak and ten small teeth posterior to it. Some difficulty has been experienced in determining the number of teeth from their indistinct character in the specimen examined, and it may be that there are actually more than we have stated. Muscular impressions and pallial line not observed.

The very slight curvature of the hinge line and the minute character of the teeth, as well as their straight transverse character, may leave some doubt as to whether or not this shell belongs to the genus *Tellinomya.*

The specific name is given in honor of Dr. H. H. Hill, of Cincinnati, who has been an active collector in various departments of natural history for a number of years, and very prominent in the organization and management, from the beginning, of the Cincinnati Society of Natural History. His private cabinet sparkles with mineral gems, is ornamented with the rarest and finest specimens of the workmanship of the Indians and the Mound Builders, and bears upon its shelves many of the choicest fossils from the Cincinnati Group.

I found this species in the upper 50 feet of the Cincinnati Group, about three miles south of Osgood, Indiana, and nearly fifty miles west of Cincinnati. The valves were found quite abundant, though not well preserved, on slabs, associated with *Beyrichia striato-marginatus.* An entire specimen was not found.

Genus *Cycloconcha*—(S. A. Miller).

[*Cycloconcha*, in allusion to the circular form of the shell.]

Shell equivalve, equilateral or subequilateral, circular or subcircular in outline, and marked concentrically. Hinge line having the cardinal teeth in the middle, with a lateral tooth of about the same length on each side.

Cycloconcha mediocardinalis—(S. A. Miller).

[*Mediocardinalis*, in allusion to the position of the cardinal teeth in the middle of the hinge line.]

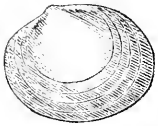

Fig. 21—*Cycloconcha mediocardinalis.*

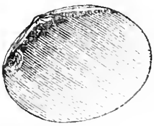

Fig. 22—Hinge line and interior of right valve.

Shell equivalve, slightly inequilateral, subcircular in outline, surface smooth, with the exception of fine concentric lines of growth, beaks projecting slightly beyond the hinge line, but not incurved. Hinge line having one small cardinal tooth beneath the beak, deeply bifid, and one lateral tooth on each side of about equal length. The cardinal tooth is somewhat trigonal, slightly arcuate on the posterior side and prolonged posteriorly. Pallial line is not distinct in the specimen examined, nor are the muscular impressions, though one may be doubtfully traced at the anterior end of the anterior lateral tooth.

Greatest length of specimen, 36·60 inch; greatest breadth, 28·60 inch.

The general form of this shell has a striking resemblance to the modern *Cyclas*.

Found back of Newport, Kentucky, at an elevation of about 150 feet above low water-mark, and at the excavation for Columbia avenue, in Cincinnati, at about the same elevation. As I only know of two specimens having been found, and one of them a valve, both of which I found myself, I am compelled at present to mark the species rare. Range unknown.

Cyrtoceras Vallandighami—(S. A. Miller).

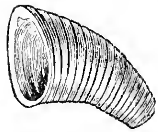

Fig. 23—*Cyrtoceras Vallandighami.*

Shell rather strongly curved. Section nearly circular, the dorso-ventral diameter a little longer than the lateral, occasioned by an oval prolongation for the siphuncle on the dorsal margin.

Surface smooth so far as observed. Siphuncle small and in contact with the shell on the dorsal side.

The specimen figured has 19 septa; length in a direct line on the dorsal side, $\frac{55}{60}$ inch; ventral side, $\frac{32}{60}$ inch; diameter, large end, from ventral to dorsal side, $\frac{31}{60}$ inch; small end, $\frac{10}{60}$ inch; length of septa on the dorsal side, at large end, $\frac{4}{60}$ inch; small end, $\frac{2}{60}$ inch.

The chamber of habitation has been broken from the large end, and has not been observed in other specimens.

The specific name is given in honor of Mr. George Vallandigham, of Cincinnati, an active collector, who found the specimen near the top of the hills at Cincinnati. Other collectors have found fragments and inferior specimens, but it may be regarded as an extremely rare species.

Beyrichia Duryi—(S. A. Miller).

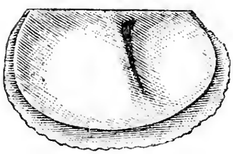

Fig. 24—*Beyrichia Duryi.* Magnified 25 diameters.

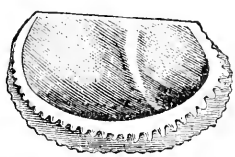

Fig. 25—Interior of left valve. Magnified 25 diameters.

Shell small, semi-elliptical, rounded at both ends, and slightly truncated obliquely at the dorsal angles. More convex anteriorly than posteriorly. A single depression, slightly arcuate, extends from the dorsal margin two thirds across the shell, situated about one third the length from the anterior end. The outer edge of the border around the basal margin is notched or finely crenulated. This is plainly visible in an entire specimen.

The interior of the valves is characterized by a line of crenulations on the inner border of the rim, as well as upon the outer border. The crenulations on the inner border are the most prominent, and from which the rim is depressed to the outer border.

Length, about $\frac{3}{60}$ths of an inch; width, about $\frac{2}{60}$ths of an inch.

It may readily be distinguished from the *Beyrichia tumifrons*, which it most nearly resembles, by the single depression across the surface, instead of two sulci. It differs also in having a wider rim and being smaller in size.

I found this species on the top of Vine street hill, in Cincinnati, about 430 feet above low water-mark. Not observed elsewhere. This may be, however, on account of its being so small that it is scarcely visible to the naked eye.

The specific name is given in honor of Mr. Charles Dury, of Cincinnati, a devoted naturalist and artist, whose handiwork in taxidermy and in the preparation of insects ornaments the finest museums in the city, and whose mind is broad enough to lead him to embellish his own cabinet with the fossils of the Cincinnati Group.

Beyrichia striato-marginatus—(S. A. Miller).

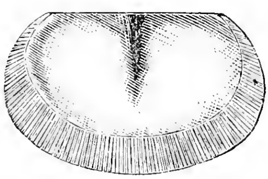

Fig. 26.—*Beyrichia striato-marginatus*, magnified about 20 diameters.

Shell small, semi-elliptical; dorsal margin straight, rounded at both ends; basal margin elliptical. Valves strongly convex, with a single depression extending from the middle of the dorsal margin, at right angles, about half the breadth of the shell. Border one third the width of the shell, and finely striated or lined from the shell outward.

Length about $\frac{4}{60}$th inch, and width about $\frac{2}{60}$th inch; convexity nearly as great as the width.

I found this species in the upper fifty feet of the Cincinnati Group, about fifty miles west of Cincinnati, and about three miles south of Osgood, Indiana.

Beyrichia Chambersi—(S. A. Miller).

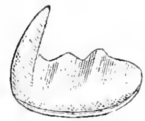

Fig. 27—*Beyrichia Chambersi*, magnified about twelve diameters.

Shell small, subreniform, dorsal margin straight, nearly as long as the entire length of the shell, basal margin subelliptical; anterior end wider than the posterior. The body of the valve is crossed by two broad, deep sulci, one of which is situated immediately behind the eye tubercle in the anterior third, the other in the middle third of the shell. The projecting basal margin is marked with a depression throughout its length, and bordered with a carinated edge.

The eye tubercle is about as long as the breadth of the shell, and rises like a half cone from the extreme anterior end, with the flattened face in the rear marked by fine oblique lines, very much resembling in appearance, when magnified, the teeth of a comb.

Greatest length of the shell about $\frac{1}{15}$th inch; breadth, one third less.

This species is readily distinguished from all others by the remarkable eye tubercle. In other respects it most nearly resembles *B. oculifer* (Hall), though not exactly corresponding with it.

I first found it in the excavation for Columbia avenue, in Cincinnati, about 150 feet above low water-mark; subsequently I found it at Richmond, Indiana, in the upper part of the Cincinnati Group, thus indicating that its range is co-extensive with the exposure of the blue limestone. I found, however, only one slab at Richmond and two at Columbia avenue bearing the fossil, and do not know of any others having been found, but, considering its great range, we must expect to find it in some locality in great abundance, and the only reason this has not thus far been accomplished is most likely owing to the extreme minuteness of the fossil.

The specific name is given in honor of our most eminent naturalist and learned entomologist, V. T. Chambers, Esq., of Covington, Ky.

Tentaculites Richmondensis—(S. A. Miller).

Tube free or detached, straight, conical, gradually tapering from the aperture to an obtuse point. Surface marked by strong encircling annulations or constrictions, which are crossed by very fine, regular, longitudinal striæ.

Length of a specimen about one inch; diameter at the aperture about 1¼ lines; width of the annulations at the aperture about half line, which gradually diminish to less than one quarter that size, and become nearly obsolete as they approach the closed end of the tube.

While some of the tubes appear to be slightly curved toward the point, yet the numbers observed, which are broken across each other and across coral stems and other inequalities of the surface with which

Fig. 28—*Tentaculites Richmondensis*, magnified from 1 inch to 1½ inches in length.

they came in contact (as shown by Fig. 28), indicate that the tubes were very slightly, if at all, flexuous.

They were found in the upper part of the Cincinnati Group, near Richmond, Indiana, by Mrs. M. P. Haines, on slabs, dispersed and scattered in every direction, in great abundance. They do not appear to have ever been attached to each other or to any other body, nor to have lived in clusters, yet on one particular slab, not more than six inches square, in the cabinet of Mrs. Haines, there may be more than a hundred tubes scattered, wholly without order, in every direction. A slab, however, of that size, with a dozen of these tubes on it, may be regarded as a reasonably good specimen.

The tubes have a marked resemblance to *Conchicolites ? flexuosa* (Hall), though they may be readily distinguished by their much larger size, straight instead of curved form and free instead of attached habit. While I think that the latter are not always curved nor always attached, yet that is the general condition in which they are found, but this species does not appear to have ever been attached, and it is doubtful whether it was in the least flexuous in its living state.

Buthotrephis ramulosus—(S. A. Miller).

Fossil ramose; stems branching; branches bifurcating, with very little change in size. Diameter of stems and branches from $\frac{1}{16}$th to $\frac{1}{10}$th inch. Structure not distinct, but has a granular appearance, as if from some change in its character.

This fossil appears to have formed the nucleus around and through which blue clay nodules, from two to ten inches in diameter, were formed at the bed of the ocean.

These clay nodules, or indurated marl stones, form entire layers of strata for hundreds of feet in length, between six and twelve feet above low water-mark, under the bank of the Ohio river, in the first ward of Cincinnati, below Mowry's car wheel works. They are also found on the Kentucky shore, opposite the foot of Fifth street, and opposite to and above the mouth of the Little Miami River.

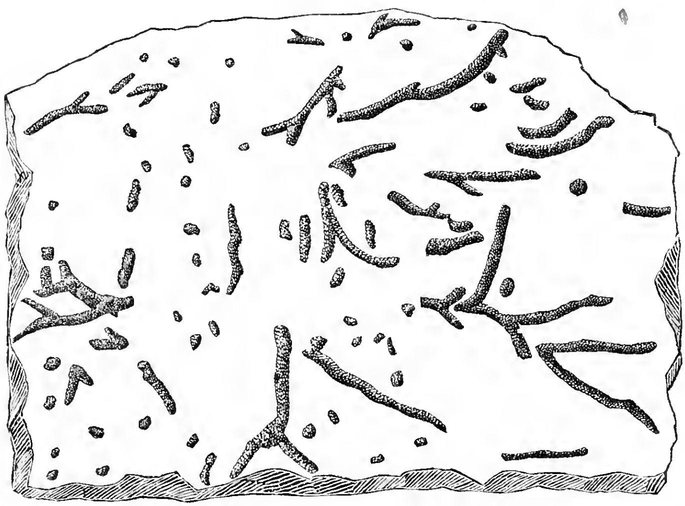

Fig. 29.—*Buthotrephis ramulosus*, showing the ends and the branching stems as they appear on a nodule.

The fossil is not known except in these indurated blue marl stones, where it is found ramifying them in every direction. Nor is it known in the nodules of the same general character which are found in the higher rocks of the Cincinnati Group.

It is a common fossil.

Letter from Professor Nicholson on the Genera Conchicolites and Ortonia.

UNIVERSITY COLLEGE,
TORONTO, March 30, 1874.

S. A. MILLER, ESQ.,

Editor of the Cincinnati Quarterly Journal of Science:

SIR—I observe an article by you in the first number of the Cincinnati Journal of Science, in which you criticise the genera *Conchicolites* and *Ortonia*, founded by me, as well as some of the species of these. I have not time at present to attempt to reply to the criticism at length, but I trust you will allow me to make a few remarks upon two of the points touched upon in your paper, and that you will give publicity o this letter in the next number of your valuable journal.

In the paper to which I have alluded, you come to the conclusion that the differences which separate the genera *Conchicolites* and *Ortonia* are of merely specific value, and that the species which I have named *Ortonia conica* and *O. minor*, will have to stand as *Conchicolites conica* and *C. minor*. As regards this point, you must allow me to remark that your conclusion is illegitimate, and not, under any circumstances, permissible. The validity, or the reverse, of a genus, is invariably tested by the *first* species of the genus which may have been described, and no genus can be abolished upon the ground that species not belonging to it have subsequently to its definition been placed under it. It is possible (though I do not think it to be the case), that there may be nothing more than specific differences between the forms described by me as *Conchicolites corrugatus*, *Ortonia conica*, and *O. minor;* but this could in no way affect the value of the genus *Ortonia*. My genus *Conchicolites* was not founded upon *C. corrugatus*, but upon *C. gregarius;* and the characters of this latter are beyond all question such as to demand a generic separation from the forms subsequently referred by me to *Ortonia*.

If, therefore, you should prove to be right as to the close affinity between *Ortonia conica* and *Conchicolites corrugatus*, you would still be in error as to the conclusions which you draw from this fact. Instead of this fact necessitating the abolition of the genus *Ortonia*, and the reference of *O. conica* and *O. minor* to the genus *Conchicolites*, it would simply necessitate our removing *Conchicolites corrugatus* to the genus *Ortonia*. We should thus have under *Ortonia* the three species, *O. corrugatus*, *O. conica*, and *O. minor*; and the genus *Conchicolites* would then contain only the single species, *C. gregarius*. I do not think that this course will be adopted; for the specimen described by me as *Conchicolites corrugatus* was very unlike those which I refer to *Ortonia*, more especially in the fact that the tubes are only attached by their bases; but under any circumstances, the validity of the genus *Ortonia* will remain unaffected.

In the second place, it is implied that I did not give credit to Dr. H. H. Hill for the discovery of the specimen of *Conchicolites corrugatus* described by me. As regards this point, I would simply mention that (as stated in my paper,) the specimen in question was forwarded to me by Prof. Orton, that the name of its discoverer was not mentioned to me, and that I was consequently unable to state by whom it had been discovered in the first place. Indeed, from the fact that Prof. Orton, no doubt from pure inadvertance, did not mention to me who had discovered the specimen, I presumed that it belonged to the State collection. Whilst, therefore, my apologies are due to Dr. Hill for not mentioning his name in connection with *Conchicolites corrugatus*, I trust he will find no difficulty in believing that my omission to do so was due to ignorance, and by no means to willful neglect.

I remain yours faithfully,

H. ALLEYNE NICHOLSON.

[Professor Nicholson first described the genus *Conchicolites* founded upon the species *Conchicolites gregarius*, and no doubt is entertained about the generic and specific characters. He next described the *Conchicolites corrugatus*, and if he was right in placing this species in the genus *Conchicolites*, then there can be little doubt that the genus *Ortonia* is a synonym, and should be stricken from the list of names. He described the genus *Ortonia*, founded upon the species *Ortonia conica*, and in his own language: "The validity, or the reverse of a genus, is invariably tested by the *first* species of the genus which may have been described." Now, this *conica* and *corrugatus* can not be distinguished by generic differences, and it remains an open question whether or not they belong to the same species. Furthermore, the *conica*, *corrugatus*, and *minor*, so far as differences have yet been ascertained, must be placed in the same genus.

The question first to be considered is whether or not the *corrugatus* belongs to the genus *Conchicolites*. It certainly does in the opinion of Professor Nicholson. It does in my opinion. By turning to pages 7 and 8 of the January number of this journal, the reader can compare the specific description with the generic, and no doubt he will arrive at the same conclusion. If he has a specimen of the *corrugatus* and compares it with the generic description, he will necessarily come to the same result. Such comparison and observation must be satisfactory.

The next thing to be considered is whether the *conica*, on which the genus *Ortonia* is founded, is generically distinct from *Conchicolites*. Of course it can not be so distinct unless it differs generically from the *corrugatus*. Professor Nicholson says, it "is distinguished by the much more complete mode of its attachment, and by the fact that the tubes are never attached socially, in clustered masses, growing side by side." But the fact is that one species has about as complete and full attachment as the other, differing possibly in the fact that *corrugatus* attaches at the point as well as at the side, while *conica* attaches only at the side; and that both species are alike in social habits, and found alike in clustered masses. These are all the points of difference relied upon by Professor Nicholson, unless he claims that the *corrugatus* is composed of a succession of imbricated rings, the wider ends of which are directed toward the mouth of the tube, while the *conica* is a flexuous tube, not composed of such rings. If there is such difference, I have been unable to discover it, and until that difference is established I shall insist that there is no genus *Ortonia*, and that the three species described, from Cincinnati, by Professor Nicholson, are *Conchicolites corrugatus*, *Conchicolites flexuosa (conica?)* and *Conchicolites minor*.]—EDITOR.

Descriptions of New Species of Fossils from the Lower Silurian Formation. Cincinnati Group. By U. P. JAMES.

Avicula corrugata—(JAMES).

Shell (left valve) oblique, subrhomboidal; cardinal line greater than the breadth of the shell farther forward; umbone prominent; beak compressed; anterior ear rounded on a line with the margin of the shell: posterior ear triangular, extending beyond the margin below. Anterior umbonal slope abrupt; posterior slope gradual to the point of the ear and the back margin. Surface marked by crowded concentric lines of growth, strongly corrugated from the umbone to the front, giving to that part of the surface a finely sculptured appearance, but not extending to the wings or ears.

Breadth, measuring along the cardinal line, about one inch; length from the beak obliquely to the front, seven eighths of an inch.

Position and locality—upper part of the Cincinnati Group, Wayne county, Indiana. Collected by U. P. James.

Avicula Welchi—(JAMES).

Shell oblique, about as long as broad; cardinal line extending a little beyond the margin of the shell posteriorly, forming a slightly projecting ear; anterior not projecting; beak rather prominent; umbone somewhat elevated; anterior slope abrupt; posterior slope abrupt to the base of the wing, then very gradual to the margin back. Surface marked by fine concentric lines.

Breadth of a large specimen, about three lines; length from the beak, obliquely, to the front, a little less than three lines.

I name this beautiful little species after Dr. L. B. Welch, of Wilmington, Ohio, an enthusiastic worker in the paleontology of Southwestern Ohio.

Position and locality—upper part of the Cincinnati Group, Clinton county, Ohio. Collected by U. P. James.

Streptorhynchus (Strophomena) elongata—(JAMES).

Shell subtrigonal; resupinate, broader than long; cardinal line extended beyond the width of the shell farther forward, deflected at the angles; shell narrowing rapidly to the front, giving it a triangular outline.

Ventral valve concave; beak somewhat elevated and projecting, minutely perforated; cardinal area rather wide, narrowing gently from the beak to the extremities; foramen triangular, closed. Interior showing the hinge teeth prominent and sharp, subtrigonal, roughly striated on the cardinal line; dental ridge extending forward, nearly inclosing an oval-shaped depression, divided by a slight mesial ridge; cardinal margin linear and prominent; outside of the oval-shaped depression, toward the free margins, in perfect specimens, the surface is coarsely punctured, and the margins roughly thickened.

Dorsal valve convex in the middle, sloping rapidly to the free margins; depressed or nearly flat on the umbone and at the beak; a shallow mesial sinus, in some cases from the beak to the middle of the shell; beak not projecting; cardinal line straight, linear. Interior showing the cardinal process small, divided at the beak into two sharp tooth-like parts, directed obliquely forward; socket elevations prominent, slightly oblique. Other interior features not observed.

Both valves covered with fine radiating striæ of nearly uniform size, increased by interstitial addition, and crossed by delicate concentric lines.

Breadth of a large specimen, along the cardinal line, is 1⅝ inches; length, from beak to front, less than one inch.

Position and locality—upper part of the Cincinnati Group, in Ohio and Indiana. Collected by U. P. James.

Strophomena declivis—(JAMES).

This shell is remarkable for the manner in which it is arched or bent over. Cardinal line of the ventral valve straight; area narrow; beak slightly projecting; cardinal line pointed at the extremities, extending, apparently, beyond the width of the shell below (owing to the sudden depression or curve of the lateral margins, directly forward of the points of the cardinal line, it has this feature); lateral and front margins bent over at nearly right angles with the plane of the exterior of the valve. Shell slightly convex from the beak to the extremities of the cardinal line, and about two thirds of the distance from beak to front, giving to the umbonal convex surface a subtriangular form.

More than half the area of the shell is bent suddenly over. Surface covered by rounded radiating striæ, a central and strong one more prominent than the others; about every fourth or fifth striæ larger than the ones between; crossed by fine concentric lines. Striæ increased by interstitial addition. Dorsal valve not observed.

Width, measuring along the cardinal line, seven eighths of an inch; length about the same.

Position and locality—Cincinnati Group, near Boyd's station, on the Kentucky Central Railroad, about 50 miles south of Cincinnati.

Collected by U. P. James.

Streptorhynchus (Strophomena) retusta—James.

Shell subquadrate, or semi-oval, resupinate, cardinal line varying from a little less to a little more than the width of the shell farther forward, deflected at the extremities. Ventral valve broadly concave; beak, in old specimens, prominent and projecting, perforated; cardinal area broad in the middle, narrowing to the extremities; foramen triangular, closed; from six to sixteen strong plications at right angles, or sloping inwardly along the cardinal line. Interior—Cardinal edge prominent; hinge teeth sharp, oblique; dental ridge encircling a saucer-shaped cavity, open in front, with rather an obscure mesial ridge and coarse oblique striæ. The whole interior outside of the cavity shows a rough or coarsely punctured surface.

Dorsal valve slightly convex on the disk, sloping to the free margins, and curving upward at the extremities of the cardinal line; flat or depressed near the beak; cardinal line nearly straight, area linear; plications as on the other valve. Interior—Cardinal process bifid, prominent; sockets trigonal, rather deep, oblique; socket ridges prominent; four or five longitudinal ridges commencing just below the cardinal process, extending about two thirds of the distance to the front; other parts of the surface, to near the free margins, roughly granulated; striated along the lateral and front margins.

Surface of both valves (exterior) covered with rounded radiating striæ, increased by implantation, of nearly uniform size in some cases, in others alternating, or every third or fourth one stronger than the ones between, crossed by fine concentric striæ, which, in some of the older specimens, is rather obscure.

Breadth of a large specimen, on the cardinal line, 1⅝ inches; length, 1⅛ inches. There is, however, some variation in these proportions, and some of the young shells are not much over half an inch each way.

This shell has been labeled *Strophomena subtenta*, Conrad (*S. plicata*, James); but it is clearly distinct from that species, the only resemblance being the plications on the cardinal line, and they differ materially, being much less in number, in *subtenta*, more oblique, and less distinct; shading off in different individuals to almost nothing. The internal markings are very different.

Professor Billings, in his work on the "Palaeozoic Fossils of Canada" (p. 130), has a shell, described and figured, strongly resembling our species, and referred to *S. subtenta*, Conrad, which (for the reason given) it does not appear to be.

Position and locality—upper part of Cincinnati Group, in Ohio and Indiana. Collected by U. P. James.

Notes on Freshwater Mollusca, found in the vicinity of Chicago, Illinois.

By W. W. Calkins.

The writer has pretty thoroughly worked up the species inhabiting waters contiguous to Lake Michigan, and connected with it. A large part of the shore, for many miles south and east of Chicago, is low and marshy. At no distant day the lake extended much farther inland than it does now. But having receded, the waters left a low coast and immense swamps, bayous, and small streams, which cover thousands of acres. The Calumet Swamps formerly had their northern limit about eight miles from the Chicago river. But the rapid growth of the city, and the speculation in real estate has now redeemed a large portion of what were a few years ago barren, watery wastes, as far as South Chicago, at the mouth of the Big Calumet river. Immense ditches, affording effective drainage, traverse the country in every direction, so that land valued only a few years since at not over ten cents an acre, is now selling for as many hundreds. In the same bogs, where, four years ago, naught was heard but the croak of the frog and the scream of water fowl, may now be seen the surveyor's stakes, and placards advertising to the passer-by the advantage of buying a few swamp lots. Here I have often collected hundreds of molluscs. Now, the dry earth and peat deposits are filled with the dead shells. In the pursuit of my favorite science, I am now obliged to travel from twelve to fifteen miles. Calumet, Hyde, and Wolf Lakes, and the Calumet river, are the most accessible points for the collector, and South Chicago a good starting point. A small dredge with a handle from fourteen to twenty feet long, and a boat, are indispensable, as most of the species are found in deep water. I have often dredged up as many as a thousand shells at a single haul. Some species still live in the Chicago river, notwithstanding the immense sewage of the city. The species enumerated in this paper are also common to Lake Michigan. The following is the result of my observations:

Limnæa reflexa, Say—A very abundant shell in all our waters. *Limnæa zebra*, Tryon—Abundant in the Calumet and other streams. Without doubt, the same as *reflexa*; only found in July and August, when *L. reflexa* changes, under the influence of the atmosphere and a hot sun, from its usual appearance to more brilliant colors. *Limnæa appressa*, Say—This beautiful species is very abundant in the Calumet river, and in the lakes before mentioned. It attains a larger size than any I have seen from other points. *L. appressa* and *L. jugularis*, of Say, have both been referred to *L. stagnalis*, Linn. But the first I consider a distinct species. It is always longer and more slender, a character that maintains itself fully in the young shells. *L. jugularis* more resembles *stagnalis*, especially in the dilation of the last whorl. Both species may be found in the same localities. *Limnæa palustris*, Muller—A varied shell and abundant. *Limnæa caperata*, Say—Abundant. *Limnæa umbrosus*, Say—An abundant shell. Whether entitled to the name of a distinct species, I will not assume to say. Of the genus *Physa*, two species are found in our waters—*Physa gyrina*, Say, and *Physa heterostropha*, Say; I have not, as yet, seen any others. The *Physas* excel all other *Limnæidæ* that I have seen in the quickness of their movements and their tenacity of life. I have seen them attack bugs with the greatest ferocity, and drag them beneath the water. When removed from their native element, they live twenty-four hours or more, and exhaust themselves in the vain effort to reach a more agreeable situation. The following species of *Planorbinæ* occur plentifully: *Pla. campanulatus*, Say; *Pla. trivolvis*, Say—very large; *Pla. parvus*, Lea.; *Pla. bicarinatus*, Say. Of *Segmentina*, we have *S. armigera*, Say. The genus *Valvata* is represented by *V. tricarinata*, Say, in the deeper waters, and *V. sincera*, Say, in the swamps. The former I dredged from a depth of fourteen to twenty feet. The finest species of *univalves* we have, is *V. contectoides*, W. G. B. The shells are found in the Chicago river, but finer and more abundant specimens come from the Calumet and Lake Wolf. *Melantho subsolidus*, Anth., are found abundantly. *Melantho coarctata*, Lea, occurs in the Chicago river. This is probably the *exilis*, Anth. Of the smaller species, *Byth. obtusa*, Lea, I brought up in the dredge from the depth of fourteen feet. *Somatogyrus depressus*, Tryon, I also found at a depth of twenty feet. *Amnicola Cincinnatiensis*, Anth., I dredged from the same localities as the two former species. There is some doubt, however, whether this is that or a new species. Of the family *Strepomatidæ*, so prolific in species south of the Ohio river, and so interesting to the naturalist on account of its varied forms, we have but two representatives in this section; they are *Try. subulare*, Lea, and *Gon. virescens*, Menke. Both are diminutive in size compared with those from other localities. The depth and semi-stagnancy of the waters, and unfavorable food, are undoubtedly the cause of this. *Sphæriums* are very abundant at all depths. Among them are *Sph. simile*, Say; *Sph. partumeium*, Say; *Sph. transversum*, Say. We have the following *Pisidiums*: *P. abditum*, Prime., and *P. compressum*, Prime. The family *Unionidæ* furnishes the following species: *U. cornutus*, Barnes; *U. gracilis*, Barnes; *U. gibbosus*, Barnes; *U. luteolus*, Lam.; *U. occidens*, Lea; *U. rectus*, Lam.; *U. pustulosus*, Lea; *U. pustulatus*, Lea: *U. rubiginosus*, Lea; *U. elegans*, Lea; *U. undulatus*, Barnes; *U. verrucosus*, Barnes; *U. ellipsis*, Lea; *U. tuberculatus*, Barnes. In the subgenus *Margaritana*, we have *M. complanata*, Barnes. Of *Anodontas*: *Ano. footiana*, Lea; *Ano. imbecillis*, Say: *Ano. plana*, Lea. The foregoing embraces the species collected by myself within the last four years. The bivalves are so common and well known that they present few points of interest. The univalves are likely to prove most interesting from the diversity of form in described species, which has occasioned numerous synonyms. The enormous synonomy of American shells is well known. Take, for instance, the genus *Succinea* and *Physa*. When every part of the country shall have been thoroughly worked up, and suits of shells have undergone the analysis of study and comparison, we shall have a general *weeding out* of superfluous species. This process will leave but a small number, comparatively, entitled to a permanent place in the catalogue. Such a work might bring dismay to species-makers, but would be for the lasting benefit of conchology, and save the future investigator much labor and perplexity.

Remarks on Unio Sayii and Unio Camptodon, before the Cincinnati Society of Natural History, at the Meeting in May. By Dr. C. A. Miller.

I desire to offer a few remarks this evening upon conchological nomenclature, but more especially upon *Unio Camptodon*, Say, and its generally received synonym, *Unio Sayii*, Ward. I shall present for your consideration the original descriptions and remarks of Mr. Say upon the *Unio Camptodon*, and of Mr. Ward upon the *Unio Sayii*, and afterward the names of such shells as are regarded by Mr. Lea, in his synopsis of 1870, as synonyms of this species.

A correct and undisputed nomenclature is the first thing necessary in the study of any subject, and the most important point to be settled in the pursuit of this portion of natural science. Want of uniformity in regard to this has ever been the dark spot upon the body politic of the shell world. Why a poor, little, innocent shell should be burdened with so many names, and its moral standing materially affected in its own country by long and bitter controversy, respecting its true and lawful name, is a subject of deep interest to the conchologist; and when the shells shall each be known by a single name, the beauties of this branch of natural history will be more readily appreciated, general interest may be excited, and conchology may become a popular study.

I shall now proceed to give you Mr. Say's descriptien of *Unio Camptodon*, Dr. Ward's description of *Unio Sayii*, and a few remarks thereon of my own.

Unio camptodon—(Thomas Say).

[American Conchology, part 5, plate 42. August, 1832. Specimen from New Orleans.]

Shell moderately thin, transversely oblong-oval, a little compressed, dark brownish or blackish; beaks with regular small undulations, behind the middle but remote from the posterior edge, but little prominent; ligament slope somewhat compressed, with two distinct compressed lines; umbonal slope not elevated above the level of the disk; anterior margin a little prominent toward the base, and rounded; lunule large; posterior margin prominent, extending far behind the beaks and rounded; base a little contracted in the middle; within, milk white; teeth—a single, rather long, oblique, undivided primary tooth in each valve; lateral teeth rather slender, toward the tip a little arcuated. Beaks distinct from the posterior margin; lamelliform teeth arcuated at tip.

Unio Sayii—(Dr. Charles J. Ward).

[American Journal of Science. January, 1839. Vol. 35, p. 268. Specimen from Ohio.]

Shell subrhomboidal, inequilateral, transverse, compressed; valve thin, beaks slightly prominent, incurved, and *divergingly* wrinkled; cardinal teeth oblique, *single* in the right and *double* in the left valve: lateral teeth *slightly* curved; nacre white. Diameter, 1; length, 1.6; breadth, 2.8 inches.

Shell inequilateral, transverse, subrhomboidal, compressed; posterior and superior margins rectilinear; basal margin curved; anterior margin regularly rounded; valves thin, translucent; beaks slightly prominent, incurved, and divergingly wrinkled, placed near the anterior margin; umbonal slope subcarinate, carina somewhat elevated; ligament long, narrow, nearly straight and partially concealed; epidermis pale yellow, inclining to cupreous on the umbos; glabrous, with indistinct capillary rays of a lighter color extending over the whole disk; lines of growth black, and very distinct; two faintly impressed lines diverging from under the points of the beaks and extending to the posterior basal margin; cardinal teeth very oblique, not prominent, single in the right and double in the left valve, slightly crenate; lateral teeth lamellar, slightly curved; anterior cicatrices distinct, posterior confluent, dorsal situated horizontally across the cavity of the beaks and distinct; cavity of the beaks shallow and rounded; nacrie white, slightly iridescent over the entire surface of the valve, with faintly impressed striæ or rays diverging from the cavity of the beaks and extending to the basal margin.

Since Mr. Say mistook the anterior for the posterior margin, and the posterior for the anterior margin of our fresh water bivalves, this must be taken into consideration when reading and comparing his description of a shell with that of other writers.

After the description of *Unio camptodon*, Mr. Say makes the following observations:

"This interesting new shell was sent to me by Mr. Barabino, who discovered it opposite to New Orleans, in ponds. An exterior view of the shell would not immediately distinguish it from *Alasmodonta edentula, nobis*, but the inner surface is quite different, and the armature of teeth separates them generically."

Upon a careful comparison of the descriptions here given, and an equally careful inspection of the shells, we find numerous points of difference between them; differences so great as to enable us readily to distinguish either shell, and to select them easily from all other shells known. Our attention is necessarily directed, in the first place, to the general contour of each shell and its external appearance; then to the interior surface of the valves. In the *Unio camptodon* we observe a slight depression on the disk, which is continued to the basal margin, causing the shell to be slightly arcuate, its length really shortened, and its sides compressed, as though it had grown between two rocks, and was thereby unable to attain its full size. Posteriorly the shell retains its length, so that the upper and basal margins seem to remain exactly parallel for a distance of fully one half the width of the shell. The beaks contain about six small undulations, very short, and appear nearly parallel, extending lengthwise.

In the *Unio Sayii* we have a full rounded umbo, the basal margin in conformity with this is very much curved, regularly approaching the ligament slope, so that the shell posteriorly tapers steadily, and almost uniformly to the posterior margin. The beaks present ten or more undulations or wrinkles; but we see they more nearly conform to the direction of growth, each succeeding wrinkle being larger and extending nearly around the former, causing the beaks to be wrinkled in the direction of the width, and occupying the first year's growth of the shell.

When we examine the internal surface of the valves, we readily distinguish those differences in the number and position of the teeth, which are always regarded as of so much importance in classifying the *Niades*. In the *camptodon* we have a single cardinal tooth in each valve; in the *Sayii*, we have *two* cardinal teeth in the left, and only one in the right valve, a difference sufficient alone to characterize them as distinct species. I trust that I have called attention to enough important points of difference to remove all hesitation about placing the *Unio Sayii* in our list of Cincinnati shells, and in excluding the *camptodon* therefrom. It is really a southern shell, never having been found in this region.

Mr. Lea gives as a further list of synonyms for the *Unio camptodon*: *Unio declivis*, Conrad; *Unio electrinus*, Reeve; *Unio rhomboideus*, Dr. Ward's MSS.; and *Unio suberoceus*, Conrad.

From *Die Silurische Fauna des Westlichen Tennessee*. By Dr. Ferdinand Rœmer. [Translated by Chas. W. Dietrich, for this journal.]

Genus *Palæomanon*.—(Rœmer).

This is a free sponge, entirely detached, of a cup or goblet form, displaying upon its upper surface large dispersed openings, the space between the openings having the appearance of a very finely punctured web.

This genus is distinguished from all sponges in the later formations by the absence of any epitheca. It is hardly possible to include it with *Astylospongia*, with which, however, it has the common distinction of having no epitheca, on account of the gradual deflection of its outer structure, and the larger openings dispersed over the whole surface. Thus there arose the necessity of creating a new genus, the exact definition of which is, as yet, not clearly determined. Its name, when settled upon, should indicate its similarity with the forms included under the genus *Manon*, in the more recent formations.

Genus *Astræospongia*—(Rœmer).

A globular-formed, unattached sponge, its surface and entire mass filled with star-shaped bodies, which, though very regularly formed, are dispersed without regard to any order; but it displays no distinct canals or pipes.

The absence of an epitheca is as well determined in this genus as in *Astylospongia*. Not a trace of an epitheca can be discerned in the several hundreds of specimens of this singular genus. In all of them the lower part is uniformly flat or rounded. The body must have lain simply with the flat lower side next the bed of the sea.

The star-shaped bodies, dispersed over the surface and throughout the mass, are of a very different construction from the small stars that appear in *Astylospongia*. They are, moreover, larger than the latter, so much so that they appear upon the most superficial inspection of the sponge to the naked eye as noticeable bodies. Besides, they are mutually unattached, and do not, like those of the *Astylospongia*, hang together by their rays. The mass lying between the stars is wholly shapeless, and presents neither openings nor any other organic texture.

Astræospongia meniscus.—(Rœmer).

A round, globular-shaped body, concave at top and convex at bottom, having its whole surface and entire inner substance filled with regular six-rayed stars, dispersed about, in no particular order.

This is, in several respects, a remarkable body, and owing to the great number of the specimens, it is looked upon as one of the most notable elements of the Fauna. Its most noteworthy mark consists in the small star-shaped bodies which are always to be found dispersed over the surface and in the substance of the body. They are formed of six rays, resembling wheel spokes, with pointed ends, which always intersect each other, at their centers, with remarkable and unexceptional regularity, at an angle of 60 degrees. The size of the star is generally from $2\frac{1}{2}'''$ to $3'''$ from the extremity of one ray to that of its corresponding opposite one; yet there are some that are smaller, and some appreciably larger. The diameter of the rays is generally about $\frac{1}{3}'''$. However, when the star is very small, the diameter is also smaller, being at times not much more than a hair's breadth. Not seldom, too, there are between the larger stars smaller ones of the same form, with thinner rays, and they are also easily distinguished from the former, by a lighter color and a semi-transparency. In this case it would seem, upon the whole, as if the larger stars were formed by the incrustation of the smaller sort. Indeed, this formation of the larger stars seems to be very probable, in some specimens, in which the upper surface presents only a few stars, with very heavy and thick rays, but in which the entire remaining surface is covered with irregular round protuberances or tubercles, which only occasionally are grouped into indistinct stars. At times, too, the rays of the stars are crossed lengthwise by a furrow, but this would appear to be only the effect of disintegration.

In regard to the arrangement of the stars no regularity can be discovered. On the upper depressed surface, however, where they appear most numerous and distinct, they always lie in a position parallel with that surface. Beneath those that are nearest to the upper surface other stars are visible, which also present, in respect to those lying above them, no regularity, but are entirely covered by them, without any order whatever. As a rule, the stars on the lower convex side of the body are much less distinct and numerous than on the upper side. Ordinarily but few separate and indistinct traces are to be seen of them on the latter side. Yet, there are specimens in which the stars appear as perfect and numerous on the lower as on the upper side. In such cases they are often very plainly discernible on the inclined or almost perpendicular side surface of the lower half, and lie in a plane parallel with the outer side. From disintegrated or fractured specimens, it is clearly to be seen that the stars are also distributed throughout the inner mass of the body. The spaces between the stars, throughout the whole thickness of the body, are filled up with a homogenous fossil substance, in which no further organic structure can be discerned. In one of the specimens before us there is a coarse fibrous, or thin, prismatic separation (or disconnection) visible, so shaped that the fibers or their prisms run almost perpendicularly to the upper concave surface.

The substance of the fossil is in contrast with the structure of the sponges previously described, from the fact that in this genus a light gray calcareous matter predominates. The stars especially are thus composed. A fracture of the pieces generally presents the leafy structure of calc-spar. In the middle part, however, there is commonly a nucleus of dark horn-stone impregnated with calc-spar discernible, and, at times, silicification also pervades the greater portion of the inner mass.

In respect to the outer form of the specimens, it is, on the whole, very commonly globular; without being, however, altogether devoid of certain deviations and irregularities. The upper surface is often only slightly depressed and almost level, and in other cases very much hollowed and almost of a cup form. In the latter case, the bottom part is of unusual thickness, and the entire appearance is that of a coarse cup. Only one specimen presents an entirely irregular form; it has the appearance of having been pressed together at the sides, and on one side is prolonged into a grooved formed continuation. The whole form of this specimen, which appears to have been compressed between foreign bodies in the development of its regular forms, leads us to the conclusion that the animal, in life, was possessed of a certain degree of flexibility or plasticity. Not one of the numerous specimens before us presented the faintest trace of an epithica. The body, when alive, was manifestly unattached, and lay on the bed of the sea with its concave side turned upward.

In respect to the zoological relationship of this body, the general form, which no other class of animals possess, as well as its appearance, would indicate that it is connected with the sponges, but in many other respects this species would appear to be wholly peculiar. What is, first of all, the meaning of the star-shaped bodies? They can be nothing other than *spiculæ*, or silicious needles. Yet they have never been found in any living or fossil *sponges*, in such regular star-shaped groups or in such magnitude. Moreover, the calcareous nature of the fossilized substance is remarkable. Most fossil sponges, and especially all the other species which occur in the same strata, are silicious. Here, on the contrary, the fossil is almost entirely calcareous. This proves beyond a doubt that the chemical composition of the living body was essentially different from that of others occurring with it, and which are always complete silicious sponges. This species belongs apparently to the calcareous sponges, which, as Professor Steenstrup, of Copenhagen, has shown, are frequently found in the seas of the present epoch, near the sponges in which silica predominates. Through the courtesy of M. Steenstrup, I have in my possession a specimen of an undescribed species of the calcareous sponges of Greenland, which contains three-pointed spiculæ, plainly visible to the naked eye, and easily dissolved in muriatic acid. This species of the living kinds seems to me to be analogous with the Silurian species which we are describing.

We shall now compare our species with the fossil described by Von König, under the title of *Blumenbachium globosum*, one of the numerous sponges described from other points of view. The author, in his not very extensively diffused work, *Icones fossilium sectiles*, page 3, describes it as follows: *Blumenbachium* nob (*Polypi corticati*). Polyparium globosum, externe undique obsitum stellulis prominentibus subquadratis, sæpe confluentibus, punctato-porosis, interne cavernosum, substantia fibroso cellulosa.

Blumenbachium globosum n. Ex calcareo, ut videtur, transitionis. Exemplaria duo in Museo Britannico asservata, indigena sunt; sed locum natalem nondum compertum habemus.

At first sight the description and representation of the figure appeared to me to so accurately resemble the fossil of Tennessee, that I referred the latter to the same genus, and described it under the title of *Blumenbachium meniscus.* But the more recent description and representation of the *Blumenbachium globosum* by Lonsdale, in Murchison's Silur. Syst. II., 680, plate 15, fig. 26, in which it is placed under the head of Bryozoa, shows that it is wholly distinct from the American fossil. Moreover, Morris Catal. of Brit. Foss., 2d Ed., 1854, p. 129, places this species as synonymous with the *Theonoa globosa*, Wood (Am. Nat. His., vol. xiii., p. 13), under the Bryozoa, taken from the crag of Suffolk. As it is to be presumed that the last named English author saw the original specimen of König, the relationship which I had previously referred with the American fossil falls to the ground.

On the other hand, the *Acanthospongia siluriensis*, described by McCoy (Synops. of the Silur. Foss., of Ireland, Dublin, 1846,–'67), and taken from the Silurian strata at Cong, in the County of Galway, seems to be related to the *Astræospongia*. According to description it forms an oval body, two inches in length, filled with spiculæ, in the form of a cross (X), and from two to six lines in width.

Occurrence—This species is the most frequent fossil of the Fauna, and I have, myself, collected several hundred specimens. I found them to be most frequent in the neighborhood of Brownsport, near Mound Glade. On Bear Grass Creek, too, near Louisville, this species is to be found in strata of the same age, but less well preserved.

Theocostegites Hemisphæricus—(Rœmer).

A semi-circular polypidom of from one to two inches in diameter, having its entire upper surface covered with small cellular openings, irregularly dispersed, the spaces between being filled with a compact coral mass; the flat lower surface, on the other hand, displaying only concentric wrinkles. At first sight this species would seem to resemble the *Chætetes Petropolitanus*, but further investigation shows that the cellular openings are not polygonal and do not touch each other, as in the latter, but are circular and separated by intermediate spaces, whose diameter is once again and sometimes twice as great as that of the openings themselves. The manner of the distribution of the cellular openings is something like that of the *Heliolites*, but whilst there the spaces between the openings are porous, in this case, at least upon the upper surface, the spaces are perfectly compact, without pores and holes. A border, generally somewhat raised from the surface and plainly visible, surrounds each opening.

All these characteristics conform entirely to the genus of Edwards and Haime. Yet I am by no means certain of the identity of the American fossil with that described by the French author; on the contrary, I have some hesitation in placing them in the same category. For, in the first place, the inner structure of the specimens before me could not be ascertained, and then the cellular openings have comparatively a notably smaller diameter than that of the other species of *Theocostegites*. In the smaller specimens the openings are of a needle form, and hardly visible to the naked eye as distinct points. When the upper surface is disintegrated, the cup-shaped openings are much wider, and the resemblance with the *Calamopora* or *Chætetes* is more apparent. But then the cups are separated by much denser partitions than in the latter genus.

Orthis fissiplica—(Rœmer.)

Shell depressed, convex, transverse, oval, long cardinal line not, however, equal in length to the greatest breadth of the shell. Surface covered with numerous (40 in the whole contour), radiating curved plications, which increase in number, either through bifurcation, or by intercalation, similar to bifurcation. The new plications are much less distinct than the chief folds, in as much as they run into the latter and become merged with it. The spaces between the radiating folds are marked by sharply projecting transverse lines. The perforated valve (ventral valve, Davidson,) is moderately convex, and provided with a distinct, moderately elevated umbone. The other valve is flat, with its middle part slightly depressed.

The general appearance of this species corresponds so nearly with many other species of this genus, that at first sight it would appear to be a well known form. When, however, we undertake to define it, we soon find that it can not be included with any of the known forms. Its chief characteristic lies in the disposition of the radiating folds. The increase of the latter occurs, indeed, as in other similar and related species, principally by intercalation, but the new folds do not occupy the middle of the intermediate space, but approach nearer one fold than the other, which gives it the appearance of bifurcation. The fact, too, is remarkable, that the new folds, which in other species rapidly attain the distinctness of the older ones, here retain their inferiority in size to a notable distance from their beginning. It differs from *Orthis fissicosta*, Hall. in its smaller size, finer plications, and transverse markings, as well as the unequal convexity of the valves.

From the Introduction to the Synopsis of the Acrididæ of North America.
By Cyrus Thomas, Ph. D.*

Acrididæ is the name of a family of insects belonging to the order *Orthoptera*. This order embraces a large number of species, which differ much in appearance and characters, and are known in this country generally by the common names, earwigs, cockroaches, devil's-horses, walking-sticks, grasshoppers, and crickets. Each of these names, except the next to the last, represents a distinct family of the order, thus:

Earwigs	*Forficulidæ.*
Cockroaches	*Blattidæ.*
Devil's-horses	*Mantidæ.*
Walking-sticks	*Phasmidæ.*
Grasshoppers	{ *Acrididæ.* *Locustidæ.*
Crickets	*Gryllidæ.*

It will be seen that the common name, grasshoppers, embraces two families, *Acrididæ* and *Locustidæ*, but these are quite easily distinguished from each other. *Locustidæ* includes those species usually found on the grass and trees, which have very long, thread-like antennæ—generally longer than the body of the insect; the tarsi, or feet, are four-jointed, and the female has an exserted ovipositor, more or less curved and sword-shaped. Most of the species have wings, yet there are a number entirely wingless, which reside on the ground.

Acrididæ includes those species which usually reside on the ground.

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* These explanations are so clear and instructive as to make them well worthy a reprint.

and are distinguished from the *Locustidæ* by the following characters: The antennæ are comparatively short, never exceeding the body in length, and composed of from fifteen to twenty-five joints; the tarsi are three jointed; the female is furnished at the tip of the abdomen with four very short, corneous pieces, two of which curve upward and two downward. This family includes the locusts of the eastern continent (the seventeen-year locust of the United States is a very different insect, belonging to an entirely different order). The common, red-legged grasshopper, which often does much injury to the crops in the States, is a familiar example of this family, and the destructive grasshopper of the West is another.

The *Acrididæ* undergo an imperfect metamorphosis; that is to say the larvæ and pupæ resemble the perfect insects, except in size and in the development of the wings. This is also true of all orthopterous insects, and forms one of the characteristics of the order.

The External Structure and Terminology.—In describing the insect it is to be understood as in its natural position—on its feet—the front legs standing forward, the middle and posterior ones backward, and the wings closed. As a matter of course, to examine the wings we must spread them, and to see the under side of the insect we must reverse it; but the rule applies to the relative position of the parts described. The vertex of the head is considered the extreme front, and the tip of the abdomen the extreme posterior. "Anterior," or "before," will then signify in the direction of the front of the head: "posterior," or "behind," the opposite direction; "above," toward the upper surface or back; and "beneath," or "below," toward the under surface. The entire external surface is considered as divided into four planes, reaching from one extremity to the other, as follows: The "back," or "dorsum," which is the upper surface, horizontal; the "under," or "ventral," surface, also horizontal, and the "sides" as vertical planes.

It is true there are wide variations from this theoretical form, especially in those species which approach a cylindrical shape, or where the dorsum of the promotum is raised into a high, sharp crest; yet, by retaining the idea of this theoretical form the shape and position of the parts may be more easily understood where figures can not be introduced. This idea is to be retained throughout, even in describing the separate parts; thus, we speak of the dorsum or back and sides of the head, the dorsum of the thorax, etc. "Longitudinally" and "length" will then signify in the length of the direction of the body; "transverse" and "width," from side to side; "height" and "depth," up and down. It may appear useless to add such explanations as these.

yet those who are but beginners in entomology are frequently puzzled, in reading the description of a part of the body of an insect, to know in what sense the author uses these terms; for example, whether "length" means in the direction of the longest diameter of the part, or in the direction of the length of the insect; but by knowing that these terms are always used with reference to the whole insect, there will be no difficulty in understanding the description. It often happens that by following this rule rigidly the width of a part exceeds its length, yet this must not cause us to vary from it.

The body of the insect is naturally divided into three distinct parts, each bearing certain appendages:

First—The *head* and its appendages, the *antennæ* and *palpi*.

Second—The *thorax* and its appendages, the wings and legs.

Third—The *abdomen* and its appendages, the *cerci* and *ovipositor*.

The *head* varies considerably in shape, yet the typical form may be considered an oblate spheroid, with the longitudinal diameter (from the neck and through to the face) the shortest, and its perpendicular diameter the longest. In some species the upper portion of the front is prolonged into a cone or pyramid of greater or less length (as in *Tryxalis Opomala*, etc.); in one genus (*Acrolophitus*) the vertex rises obliquely upward, in the form of a short cone or pyramid. Viewed from the side, it presents, in many species, a triangle—the face, which forms the longest line, being directed from the vertex obliquely under toward the breast (*Opomala*, *Oxycoryphus*, *Stenobothrus*, etc.); in other species it presents a parallelogram, the greatest length being up and down—*Œdipoda*, *Acridium*, *Caloptenus*, *Pezotettix*, etc.

In describing the head, its external surface may be considered with reference to four planes—the dorsum, the two sides, and the front. If a line be drawn across the back part, from the posterior margin of one eye to the posterior margin of the other, the portion lying behind this line, reaching to the margin of the pronotum, will represent the *occiput*.

The *vertex* is the portion included between the eyes, and extends forward to the point where the head commences to descend to the face; the extreme anterior point is sometimes called the *fastigium*. The variations in the form and surface of the vertex afford important generic and specific characters. In a few instances it ascends anteriorly, is somewhat horizontal, but is generally more or less deflexed; is advanced and pointed or triangular in front (*Tryxalis*, *Opomala*, *Stenobothrus*, *Tragocephala*); is obtusely rounded and blunt without carvings (*Boopedon*); is narrow and slightly furrowed (*Caloptenus*); and is broad and even transverse, that is, broader than long. Sometimes the margins are raised so as to inclose a *foveola*, or shallow cell, between the eyes, which is called the *median foveola*, or *central foveola*, of the vertex. The shape and character of this foveola appear to be constant in the species, and even in some genera, hence its importance; but caution is to be observed in comparing dried specimens, especially dried alcoholic specimens, with descriptions taken from living specimens, and the reverse, as the shrinking often causes considerable variation from what it is when living. The *lateral foveola* are two small cells, situated on the margin of the vertex, one on each side, near the front border of the eye, sometimes on the upper surface, near the edge; in other species immediately below the margin, on the deflexed portion. These are sometimes linear (*Stenobothrus*), sometimes very small and triangular (*Œdipoda*), or quadrangular, but in many genera are wholly absent.

The *face* (*facies*) is the deflexed portion in front, extending downward from the antennæ to the transverse suture, which separates it from the *clypeus*; it is generally transversed, up and down, by three *carinæ* or keels, more or less distinct; the *median carina*, or *frontal costa*, is the one extending down the middle from the fastigium, and in which the middle ocellus is placed. This carina is generally more or less sulcate or channeled; when the channel is deep, dividing it into two keels, the face is said to be *quadricarinate*. The two *lateral carinæ* extend downward from the front margin of the eyes, often bending outward toward the corners of the face. Between the frontal costa and lateral carina are the *antennal foveola*, or pits, in which the antennæ are inserted. The cheeks (*genæ*) are the convex portions of the sides below and rather behind the eyes.

Sometimes the face is deflexed, that is, directed under and backward toward the breast, but generally it is vertical or nearly so.

The portion of the head described constitutes the skull, on which are placed the eyes (*oculi*), the simple eyes (*ocelli*), and the antennæ. The position and shape of the eyes afford both generic and specific characters; as regards position, whether on the sides or advanced near the front, approximate to or distant from each other, prominent or the opposite, oblique or vertical; in respect to the shape, whether they are globose, ovoid, elliptical, elongate, or pyriform.

There are three simple eyes (*ocelli*); one (*ocellus*) is placed immediately above the base of each antennæ and near the margin of the eye, and one in the frontal costa, between the antennæ.

The antennæ are inserted in the front of the head, a little below the eyes, and consist of a number of joints, varying, according to the species or genera, from fourteen to twenty-four; they seldom exceed one half of the body in length, but (in the North American species) are always longer than the head; the usual form is cylindrical, but in many species they are enlarged and prismatic at the base, and in a few are somewhat enlarged at the tips. The joints are numbered from the base toward the apex, the first joint being the largest and subglobose, or somewhat flattened. The face is terminated below by a transverse suture, called the *clypeal* or *nasal* suture. The *clypeus* is the next piece below the suture, and is usually in the form of a transverse parallelogram, and "tucked" at the sides. Attached to the lower margin of this is the *labrum* or upper lip, the lower corners rounded, and the lower margin generally notched; the upper half has a quadrangular impression, giving this portion the appearance of a separate square piece. The suture which separates the upper lip from the clypeus may be called the labial suture.

The labrum covers the *mandibles*, or strong, corneous, upper jaws, which are furnished on the inner margin with strong teeth or serratures, presenting both cutting and grinding surfaces; thus admirably adapting them to the voracious habits of these vegetable-eaters.

Immediately behind these are the *maxillæ*, or under jaws; the basal portion or body is somewhat triangular in form; the outer lobe (*galea*) is slightly dilated, and has a small joint at the base; it is hollowed on its inner margin, which covers the inner lobe. The latter is elongate, and narrow, terminating at the apex with two sharp teeth. Near the base of these jaws are attached the *maxillary palpi*, one palpus to each jaw: these appendages resemble short antennæ, and consist of fine joints, the first and second being minute, the other three are longer, and usually about of equal length.

The under side of the mouth (or in *Acrididæ*, as in many other families of insects, we might more properly say, the back or hinder part) is covered by the *labium*, or lower lip, which is large, and consists of two lobes; the outer lobe is more or less circular in form, its surface near the exterior margin being crossed by an indenture, which gives to it, when closed, the appearance of a mandible. This member is also furnished with two appendages (*labial palpi*), resembling the the maxillary palpi, but are shorter, and composed of but four joints, the first or basal joint being very small, and often scarcely perceptible. The tongue (*lingua*) is well developed, thick, fleshy (and somewhat spatulate in form in *Acridium Americanum*); it is situated immediately forward of the labium, and between the maxillæ, and its minutely pappillate surface certainly indicates that the sense of taste is well developed. The head is connected with the thorax by the *neck* (*collum*), which is but a short cylindrical ring, usually hid by the pronotum; it is not used in describing genera or species.

The *thorax* is the middle portion of the body, to which are attached the six legs, and also the four wings, when present. In order to accommodate the strong muscles necessary to the motion of these members, it is the most robust of the three parts of the body. It consists of three parts, each composed of several pieces; the front portion, which bears the first pair of legs, is the *prothorax;* the middle portion, which bears the middle pair of legs and the upper wings (*elytra*) is the *mesothorax;* the posterior portion, which bears the third pair of legs and the under wings (*wings* proper), and to which the abdomen is joined, is the *metathorax.*

The different surfaces of these divisions are distinguished by separate names; thus the dorsal portion of the protothorax is the pronotum, and the ventral portion the *prosternum;* the dorsal portion of the mesothorax is the *mesonotum,* and is usually covered by the pronotum; the ventral portion is the *mesosternum;* the dorsal portion of the metathorax is the *metanotum;* the ventral surface the *metasternum.* The whole of the under surface of the thorax taken together is the *sternum.*

The most important of these divisions, in describing genera and species, is the *pronotum;* this is the shield which covers the front part of the body immediately behind the head, reaching down the sides, nearly or quite to the insertion of the front legs; it usually extends back on the dorsum of the thorax, so as to cover the base of the elytra; but in the subfamily *Tettiginæ* it extends back over the abdomen to its extremity. Its surface is considered with reference to three planes—the upper surface (*dorsum*) and the two sides; but there are wide variations from this typical form. When these areas are clearly distinguishable there is a raised line, sharp angle, or obtuse ridge running along each margin of the dorsum, where it connects with the side; these are called the *lateral carinæ.* In most species of the family there is a raised line or keel along the middle of the pronotum, called the *median carina;* this is sometimes but an indistinct line, in other species it is quite distinct; in some slightly elevated, when it is said to be *sub-cristate;* and sometimes it is quite elevated, when it is called *cristate.* The term carina is sometimes, though with doubtful propriety, applied to the obtusely-rounded angle formed by the deflection of the sides of the pronotum from the dorsum (as in *Caloptenus,* and even in *Pezotettix,* where the pronotum is almost cylindrical). I have, therefore, in some cases, introduced the term *humerus* or *humeral* angle, to represent this part when it can not properly be called a carina. In some cases the sides slope upward to the median carina, leaving no lateral carina or angle (as in *Tropidolophus* and *Tropidacris*); in other cases (as in *Mesops* Boopedon, some species of *Opomala*, etc.) the pronotum is cylindrical. The lateral carinæ afford important generic and specific distinctions, by their relation to each other, shape, etc., as to whether they are parallel or convergent, straight or curved, continuous or interrupted. The front margin of the pronotum seldom presents any angular points, being usually obtusely rounded or truncate; but the posterior extremity generally extends backward, in a rounded or angular form, upon the base of the elytra: in a few cases (as *Chrysochraon*, and some species of *Pezotettix*, in which the elytra and wings are wanting) the posterior margin is truncate. The *posterior lateral margins* are the hind margins running down from the extremity of the dorsum to the posterior angle of the sides.

The body of the pronotum is generally divided into four lobes by three transverse sutures or impressed lines: the lobe, or portion next the head, is the *anterior lobe*, the hindmost one the *posterior lobe*, the other two the middle lobes. In many species the two anterior impressed lines are indistinct, or wanting, but the posterior one is nearly always present, except in the *Tettigina*. These lines are sometimes designated by the numbers 1, 2, and 3, beginning with the front one and counting backward.

The general form of the pronotum affords very important characters: sometimes the width is uniform and the sides are parallel: sometimes they *diverge posteriorly*; at other times they approach each other in the middle, in which case the pronotum is said to be *constricted*, but this term applies only when the narrowest point is between the extremities. Its surface also varies: is smooth, punctured, rugose, or tuberculate.

The *mesonotum* and *metanotum* are hid by the pronotum and the wings, and are not used in descriptions, except in the case of a few wingless species of *Pezotettix*.

The *prosternum*, or under side of the prothorax, is short, and is either smooth, that is, it is without either tubercle or spine, or it is furnished with an obtuse tubercle, or a conical spine, called the *prosternal spine*. The species furnished with this spine are said to have the *prosternum armed* or *mucronate* (*Opomala*, *Mesops Romalea*, and all the group of *Acridini*); when the prosternum is without a spine it is *smooth* or *unarmed* (as *Tryxalis*, *Pyrgomorpha* and the entire groups, *Œdipodini* and *Tettigini*). This spine is either subcylindrical or cuneiform, obtuse or acute, straight or curved, etc.: these differences furnishing either generic or specific characters. Those species without the prosternal spine generally have the prosternum marked with a transverse curved groove, more or less distinct.

The *mesosternum* is the broad piece of the under side that lies between the middle legs, and is marked with one or more indentures. It varies slightly in form, and may be used in describing species, though I believe this has not been done, except in a few instances in Fischer's *Orthoptera Europea*. The pieces in front of the middle legs, extending obliquely up the sides, are the *episterna* of the mesothorax; the pieces situated externally to and adjoining the insertion of the middle legs, are the *epimera* of the mesothorax.

The *metasternum* is the under surface of the metathorax, and is situated between the bases of the hind legs, and is usually marked with a single or double indenture in the middle. The *episterna* and *epimera* of the metathorax correspond very nearly in relative position with those of the mesothorax.

These thoracic rings on their internal face furnish support for the strong muscles necessary for the various movements of the wings and legs; and if we strip them of their appendages, and cut off the posterior projection of the pronotum, limiting it to the length of the prothorax, we will at once see that they are true homologues of the abdominal segments, changed from the typical form only so far as is necessary for the support and operation of the organs of locomotion.

The *legs*, as in other insects, are divided into several parts or joints, as follows: the *coxa* is the basal joint, by which the leg is connected to the body; it is short in *Acridida*, but is usually enlarged. The *trochanter*, which is the next joint, is small, and can be best seen in the anterior pair of legs. The third piece or joint is the thigh (*femur*), and is the largest portion of the leg. The fourth piece is the *tibia* or shank, and is attached to the tip of the femur. The terminal portion, which rests upon the ground, is the *tarsus* or foot, and is composed of three joints; the first, or basal, and the third (or terminal) joints, being longer than the second (or middle) joint. The first has two transverse indentures on the under side, which give it the appearance, when seen on this side, of being three pieces, thus making the tarsus appear five-jointed; but seen from above, this shows but one, and the entire tarsus but three joints. The third, or terminal joint, is furnished at the tip with two claws (*ungues*), between which in all the groups, except *Tettigini*, there is a circular piece or pad (*pulvillus*).

The posterior legs are much longer and stouter than the anterior or middle pair, in order to fit these insects for leaping. The thighs or *femora* are swollen or incrassated near the base, to accommodate the muscles necessary for this purpose. The external face, which is sometimes called the *disk*, is marked by numerous, alternate, minute ridges and furrows, running obliquely inward and forward from each margin toward a longitudinal middle furrow, giving the entire disk a pinnate appearance; hence these minute ridges are sometimes alluded to as the *pinnæ* of the femur. The disk is bounded above and below by a small but usually distinct carina. Along the middle of the upper edge runs another keel, to which the name *upper* or *superior carina* is frequently applied. This is sometimes simply a raised line or angle; but in other cases, especially in some genera of the group *Œdipodini*, it is quite prominent. The inferior edge is generally channeled for the reception of the tibia when folded up. The outer margin of this channel or sulcus is the *lower* or *inferior carina*, and generally corresponds in prominence with the upper one. The femur affords some useful characters in describing species, by its length, as compared with that of the abdomen; by its size, whether comparatively slender or broad, by the greater or less prominence of its carina, etc.

The method by which the tibia is articulated with the femur, admirably adapts it for leaping. The apex of the femur is suddenly expanded vertically, but deeply channeled, leaving a plate on each side, between which the base of the tibia is inserted. This has here two short, right-angular bends, the articulation being at the sides of the first angle with the lateral plates of the femur; thus leaving a short lever extending upward, to which the strong extensor muscle is attached. The flexor muscle is attached beneath in the second angle, which enables the insect to draw the tibia upward into the channel of the femur.

The posterior tibiæ are furnished at the apex with about four strong spines, pointing downward, to give secure footing in leaping. The posterior face is furnished for about two thirds of its length from the apex with two rows of spines, one row on each margin.

The organs of flight consist of two upper wings, *elytra*, and two under wings, to which the name *wings* (*alæ*) is usually applied.

The *elytra* are generally in the form of an elongate oval, or an elongate parallelogram, narrowed at the base and rounded at the apex. In the perfect insect they usually reach to, or extend beyond, the tip of the abdomen; but there are numerous exceptions to this rule in many species, being much shorter than the abdomen, and in a few wholly wanting. When the elytra are absent, the wings are also absent. When folded and at rest, a portion lies horizontally upon the back, the remainder, and much the larger portion, being deflexed vertically against the sides of the abdomen. The upper edge, which forms the margin of the suture along the back when they are closed, is usually termed the *posterior* or *anal margin*, by most authors, as they consider them spread; but I usually employ the word "upper," in alluding to this portion, as I consider them closed when describing them. I also usually call the opposite edge the *lower margin*, by most authors named the *costal* or *anterior margin*. The area of each *elytron* is divided into three fields by two strong, longitudinal nerves; the larger of these nerves (or veins, as they are sometimes called), which runs a little distance from and sub-parallel to the anterior or lower margin, is the *externo median* nerve; the other, which runs from near the middle of the base obliquely upward toward the posterior or upper margin, usually reaching it a little beyond the middle, is the *interno median* nerve. The three fields into which the area is divided have received different names, in order to designate them without circumlocution. The *anal, posterior* or *upper* field, is the portion between the interno median nerve and upper margin, and rests horizontally on the abdomen when the elytra are closed. The *anterior, marginal* or *lower* field, is the portion between the externo median nerve and lower margin, being the lower area on the side when the elytra are closed. The *discoidal, intermediate* or *middle* field, is the space between the two nerves mentioned; it is very often referred to simply as the *disk* of the elytra. The *angle* of the elytra is the longitudinal ridge formed along the interno median nerve, by the sudden flexure from the horizontal to the vertical portion when closed.

When describing the wings they are supposed to be fully spread. The terms *disk* and *base* are sometimes, though not properly, used interchangeably, referring to the moiety of the wing next the body. At other times *disk* is properly applied to the middle portion. I use the term *sub-marginal area*, to designate that portion between the anterior margin and next strong nerve; *margin*, when used without any qualification, signifies the front margin. The *nerves*, or *veins*, are the ribs which run from the base to the outer margin, and form the lines of plication when at rest. The *nervules*, or *veinlets*, are the minute transverse ribs running from one nerve to another. When these are placed regularly, like the rounds of a ladder, they are called *scalariform*. In many species, especially of *Œdipodini*, the basal half of the wing is colored red, yellow, or some other bright color, which is often bounded exteriorly by a black or fuscous band, extending across the face, from the anterior to the posterior margin, generally curving along the latter, to or toward the *posterior* or *anal angle*; in other species the greater portion of the wing is black or fuscous, while in a large number the entire wing is pellucid.

The *abdomen* is the posterior part of the body which is attached to the metathorax. It is generally sub-convex on the under side, and slightly compressed laterally or sub-carinate above. It is composed of some eight or nine corneous rings or segments, which decrease in size toward the apex (though in some genera, as *Caloptenus* and *Pezotettix*, the terminal segments of the male are somewhat enlarged). The typical number of segments of the abdomen, according to Lacaze-Duthiers (who is followed by Dr. Packard, in his "Guide to the Study of Insects"), is eleven. But if we count the dorsal segments in the female, to and including the point where the upper and lower plates separate for the extrusion of the ovipositor, there are really but nine. It is true that the ninth, which folds over the upper valves of the ovipositor, shows two transverse folds besides the terminal piece over which the pre-anal plate rests; each of these is counted as a segment by Lacaze-Duthiers, thus making the eleven; but the incisions marking these folds are incomplete, not reaching the lower margin of the plate. Between the second of these folds and the terminal piece on each side issues a short process, not extending beyond the apex of this piece; these appendages are the *cerci*.

Fischer says the abdomen in both the male and female consists of nine distinct segments. Westwood remarks that the inferior surface of the abdomen in the male consists of eight segments, but only of seven in the female. Lacaze-Duthiers says the sub-genital is formed by the seventh *sternite* (ventral segment); if we consider the piece which projects forward into the posterior margin of the metasternum as belonging to the venter, and as representing the first sternite, which I am inclined to think it does, then there are eight ventral segments (sternites) in the female, and nine in the male.

Each abdominal ring is, or is supposed to be, composed of six pieces, soldered together, three to each lateral half; but for all the purposes of the present work, we may consider them as composed of but two pieces or plates, an upper or dorsal plate, called the *tergite* or *dorsal segment*, and the lower plate, called the *sternite* or *ventral segment*. The under surface of the abdomen, as a whole, is the *venter*.

On each side of the basal segment is a large cavity, either of a semi-orbicular or lunar shape, which is closed on the inside by a very slender skin of a whiteish color. This is the *tympanum*, and is supposed by some entomologists to have a certain influence upon the act of striduiation, while others believe it to be the organ of hearing; the latter appears to be the more generally received opinion at present.

The apex of the ventral portion in the males curves upward, somewhat in the form of the prow of a vessel; this curved portion, in some species appears to form the last ventral segment (sternite), but in others a transverse impression is seen, separating the apical surface from the rest. This apical portion has received several different names: as, *sub-genital lamina, sub-anal plate.* In some genera and species (*Tryxalis, Mesops,* some *Opomala,* etc.) the tip is entire, while in others it is notched.

The *pre-anal lamina,* or *super anal plate,* is the triangular piece which in both sexes lies over the anal aperture.

The *ovipositor* of the female consists of four corneous pieces, two of which curve upward and two downward, usually called the *valves*; but Lacaze-Duthiers, who has made the genital organs a special study, applies different names to the separate pairs, thus: the upper pair are his *episternites,* because they are above the little central piece, which he considers the representative of the ninth sternite; the lower pair are his *tergo-rhabdites.*

Dr. Packard says: "The ovipositor, with its accessory pieces, consists of a sub-genital plate formed by the seventh sternite; the ninth segment is complete, and the blades (tergo-rhabdites) composing the ovipositor consist of three secondary pieces united together between them."

Internal Structure.

The nervous system, according to Leon Dufour, consists of a double nervous chord, extending from the head to the tip of the abdomen along the lower part of the body, expanding at various points into ganglia, which emit a greater or less number of branches to the right and left. These ganglia are classed in three groups, according to the part of the body in which they are situated—*cephalic, thoracic,* and *abdominal.* The cephalic ganglion is the largest of the number, and is deeply emarginate in front, giving it the appearance of being somewhat bilobed; in *Tryxalis* this feature appears to be most strongly marked. In each of the thoracic divisions there is a ganglion, that of the metathorax presenting the largest number of branches.

The abdominal ganglia, of which there are some six or seven, are all small, except the last, which is next in size to that of the head, emitting to each side three important branches, connected, doubtless, with the generative organs. This system is more prominently developed in the *Acrididæ* than in any other family of the order, which has induced Léon Dufour to give them the highest rank in the order.

The digestive system consists of an alimentary canal, extending almost direct from the mouth to the extremity of the abdomen, which is divided by constrictions into four apartments or divisions. The first (*œsophagus*) is somewhat inflated in its posterior half, giving it a subconical shape, and is contained in the thorax. The *proventriculus* proper, which is formed in other families of this order, is wanting in the *Acridida*, its functions, according to Léon Defour, being performed by the *pyloric valve*, which is situated at the posterior extremity of the first portion, where it joins the next. The second, according to the author named, is the *chylific ventricle*, and is the longest portion of the canal, though not more expanded than the posterior portion of the œsophagus; its form is subcylindrical. The two last divisions are somewhat smaller than the previous ones, and constitute the intestines. The hepatic organ consists of a number of simple, elongate, cylindrical filaments, uniting with the digestive apparatus at the junction of the second and third apartments.

The salivary glands are but slightly developed in this family, reaching their simplest form in the *Tettiginæ*.

The respiratory apparatus of the *Acridida* does not differ materially from that of the other insects, consisting of a number of elastic anastomosing tubes or tracheæ, which have their origin and communicate with the external air at the stigmata, or little mouths, one of which is placed on each side of the thoracic and first eight abdominal segments.

The ovaries consist of two tubes, which are attenuate for a short distance near the base (posterior extremity, where they unite), but beyond which they are inflated, terminating at the extremity in a long, slender, cylindrical tube. From the inner side of the inflated portion extend a number of multilocular tubes, tapering to the extremity; these, when fully expanded, resemble, in their position and appearance, with regard to the main tubes, the teeth of a comb; but their natural position is one of great beauty, folded together from each side, with their points projecting forward, appearing like delicate chains. The seminal receptacle consists of a pedunculated vessel, whose closed extremity is dilated into a pea-shaped vesicle, forming the *capsula seminis*.

It has been repeatedly stated that the species of this family lay their eggs in a cocoon-shaped mass, covered with a tough, glutinous secretion, varying in number from fifty to one hundred. This may be a very common method, but it is by no means universal. It is the method followed by the migratory locusts of Europe, and, from what I learn, I am satisfied it is the same with the destructive, migratory species (*Caloptenus spretus*) of the West; but it is not the method followed by *Acridium Americanum*, which I have noticed digging into and depositing its eggs in the hard-trodden ground. I have also obtained the eggs of *C. femur-rubrum* in rotten wood, where they were placed without any apparent regularity, and without connection by any glutinous secretion. Mr. S. I. Smith has noticed the same thing in regard to *Chlaaltis conspersa*, except that the eggs are placed in two rows.

All the species, so far as I am aware, lay elongate-cylindrical eggs, those of *Chlœaltis conspersa*, according to Mr. Smith, being about 0.25 of an inch in length, while those of *Œdipoda corallipes*, according to my own observations, are about 0.30 of an inch long, and slightly bent. The young of the latter species, just before leaving the eggs, are exactly like the young larva, the legs being neatly folded against the sides of the venter and sternum, the tarsi resting against the sternum; the antennæ are laid down over the sides of the face.

The eggs are usually laid in the latter part of the summer or in autumn, and remain in their place of deposit until the following spring or summer, when they are hatched; yet it would appear, from the number of larvæ we often see late in autumn, that some species in the southern and central portions of the United States produce more than one brood in the year; but our information is not sufficient to speak positively on this point.

These insects attain their full growth by simple moltings, the larvæ and pupæ resembling the perfect form, except in size and development of the wings. According to Zinnani, the Italian *Calopteni* undergo their first moltings about the fortieth day after exclusion from the egg, the second about twenty days afterward, and the third about sixteen days later; but the number of moltings does not appear to be uniform in the different genera, six being the number usually given by the different authors. According to Koppen, *Pachytylus migratorius* molts four times, the fourth molt producing the perfect insect.

The sounds which are made by the *Acrididæ*, according to Mr. Scudder and Landois, are produced in two ways, first by rubbing the inner surface of the hind legs against the outer surface of the elytra; and, second, by rubbing together the upper surface of the front edge of the wings and the under surface of the elytra. According to Landois, the inner surface of the hind femur is furnished, along the lower margin, with a longitudinal row of minute, elegant, lancet-shaped, elastic teeth, varying in number from eighty-five to ninety-three, which are scraped across the nerves of the elytra, thus producing sound.

The species which employ the first method stridulate while at rest, producing a low, buzzing sound; this is the usual, though not universal, method of the *Stenobothri*. Those *Acrididæ* which produce sounds by rubbing their wings and elytra together, stridulate only during flight, and, as remarked by Mr. Scudder, "are nearly all confined to the genus *Œdipoda*," producing a sharp, crackling sound, resembling the noise of burning stubble. Each species appears to have its peculiar note, so that, having a knowledge of the *Orthoptera* of a given locality, we can at once distinguish the species by the sound made.

The soft, pattering sound made by some species of *Acridium* and *Caloptenus* during flight, is probably due simply to the beating of the air by the wings, as it does not appear to be confined to sex, the males only of grasshoppers being furnished with apparatus for producing notes.

On the Parallelism of Coal-Seams. By J. S. NEWBERRY. [From the Am. Journal of Science and Arts, April, 1874.

In the first volume of the final report of the Geological Survey of Ohio, Professor E. B. Andrews advances a theory in regard to the successive deposition of coal strata which, if permitted to go unquestioned, might seem to commit the other members of the geological corps to its approval, whereas, as a matter of fact, Professor Andrews stands quite alone in its support. Very briefly, his theory is this: 1st, That coal-seams have accumulated in marshes along the sea shore, and, therefore, at or near the water-level; 2d, That the subsidences by which several coal-seams were successively formed and buried were continental and general; and, 3d, That the coal-beds, from their mode of formation, must necessarily be parallel to each other, and, hence, a discrepancy in the distances from a given coal-seam, taken as a base, to two or more outcrops of what might be considered the same seam, is a proof that the coal of these outcrops belongs to different seams. Professor Andrews also says that he has never seen a coal-seam dividing into two or more distinct seams, or two seams approaching each other.

While not questioning the accuracy of Professor Andrews' report of his own observations, I am compelled to say that the facts observed by myself are not only discordant with his, but are such as seem to me to be incompatible with his theory. In the northern half of the Ohio coal-field, numerous instances of the approach and divergence of plainly continuous coal-seams might be cited. For example: On one tract of coal land in Hubbard, Trumbull county, the distance which separates the first from the second coal-seam, varies from 44 to 100 feet; coal No. 1 showing conspicuous waves or folds, while No. 2 is nearly horizontal (M. C. Read). At Fredericksburg, Wayne county, the distance between the two limestone coals, Nos. 3 and 4, is only 20 feet, but on tracing these seams down the valley of the Killbuck, they are seen to gradually diverge, until, at Millersburg, they are

80 feet apart. At Fredericksburg again, the distance between coals No. 4 and No. 6 is only about 30 feet; but in passing from this point eastward to Mineral Point, Tuscarawas county, the interval increases to 104 feet; coals No. 5 and *5a* coming in between them. At Steubenville, the interval between coals No. 6 and No. 8 varies from 502 to 564 feet; while, going westward, this interval diminishes to less than 400 feet along the western outcrop of the Pittsburg seam. On the banks of the Ohio, between Wheeling and Bellaire, the two coal-seams next above the Pittsburg bed are seen, in a single exposure, to vary from 12 to 35 feet in the distance which separates them. On the banks of the Ohio, west of Wheeling, coals No. 8 and No. 9 are about 150 feet apart; three coal-seams, *8a, 8b,* and *8c,* being interposed between them. Thirty-five miles west of this locality, the distance between coal 8 and coal 9 is only 50 feet, with no intermediate seams (Stevenson). At Morgantown, West Virginia, on the east side of the Monongahela, the interval between the Pittsburg coal and the next succeeding one above (Redstone) is over 50 feet, consisting of limestone, 14 feet; shale, 3 to 10 feet; sandstone, 35 feet. On the west side of the river, three miles below, the distance between the Pittsburg and Redstone coals is less than 20 feet; the limestone remaining constant, the sandstone having entirely disappeared (Stevenson).

Any required number of cases like the preceding might be cited, but these, as it seems to me, will suffice to show that the intervals between our coal-seams are not constant. I learn from Professors Dawson, White, Cox, and Worthen, our most experienced coal geologists, that similar examples to those I have cited are not uncommon in the coal-fields which they have so carefully studied.*

The fallacy of the theory of Professor Andrews, as I think, consists in the supposition that the subsidence of our coal areas has been always continental or general; whereas, as it seems to me, the evidence is varied and abundant that this subsidence was often very local, and that in the long interval which elapsed between the formation of one coal-seam and the accumulation of carbonaceous matter above it, the strata were sometimes warped and folded in the most local and complicated way. It is also apparent that the deposition of the materials forming the strata of the coal-measures was often quite irregular. This is conspicuously shown by the limited reach of the great sandstone wedges which sometimes locally separate or replace the more constant elements, the limestones, shales, and coal-seams. In some instances these beds of sandstone occupy narrow troughs of erosion; sometimes

* See also the report of Professor Ramsay, in the Report of the Coal Commissioners (England), vol. i., pp. 121 and 145.

they form broad, lenticular sheets. It seems to me that we have some evidence that the local accumulation of these beds of sand produced local displacement of the mud on which they were deposited, just as they do at the mouth of the Mississippi, where the displacement results in the formation of "mud-lumps." But the theory of Professor Andrews seems to me not simply untrue, but as calculated to do positive and practical harm, since teaching that a discrepancy of interval argues a want of identity in coal-seams, it tends to multiply their number and produce confusion in their classification.

Interesting Description of a part of Wyoming Territory, from the introduction to "Extinct Vertebrate Fauna of the Bridger Formation," by Prof. JOSEPH LEIDY.

Fort Bridger occupies a position in the midst of a wide plain, at the base of the Uintah mountains, and at an altitude of nearly 7,000 feet above the ocean level. The neighboring country, extending from the Uintah and Wahsatch mountains on the south and west to the Wind river range on the northeast, at the close of the cretaceous epoch, appears to have been occupied by a vast fresh water lake. Abundance of evidence is found to prove that the region was then inhabited by animals as numerous and varied as those of any other fauna, recent or extinct, in other parts of the world. Then, too, a rich tropical vegetation covered the country, in strange contrast to its present almost lifeless and desert condition.

The country appears to have undergone slow and gradual elevation, and the great Uintah lake, as we may designate it, was emptied, apparently in successive portions and after long intervals, until finally it was drained to the bottom.

The ancient lake deposits now form the basis of the country, and appear as extensive plains, which have been subjected to a great amount of erosion, resulting in the production of deep valleys and wide basins, traversed by Green river and its tributaries, which have their sources in the mountain boundaries. From the valley of Green river the flat topped hills rise in succession as a series of broad table lands or terraces extending to the flanks of the surrounding mountains.

The snows of the Uintah, Wahsatch, and other mountain ranges are a never-failing source to the principal streams; but many of the lesser branches, dependent for their supply on the accumulated snows of winter in ravines of the lower hills and plains, completely dry up as the snows disappear with the approach and advance of summer. The country for the most part is treeless and destitute even of large shrubs, excepting along some of the water courses. The principal streams are fringed with trees, consisting of cotton wood and willow, and the valleys through which they run produce mostly rushes and sedges, with some coarse grasses, as *Elymus condensatus* and *Triticum repens.* Hollows of the hills and narrow valleys, favorable to the retention of moisture, support forests of small aspens. The higher terraces and foot hills approaching the mountain ranges are covered with dense forests of aspens, pines, and firs, with a rich undergrowth of herbaceous plants. The great mountains themselves present a broad belt of pines and firs, from which project the rocky summits as bare of vegetation as the wide plains at their base. Many of the lower hill sides and hollows in certain situations are sparsely covered with cedars, most of which are very old in appearance, and remarkably distorted, twisted and broken.

The principal growth of the plains consists of sage bushes, curiously distorted and split, so as to remind one of the cedars just mentioned. In some places the sage bushes are mingled with or replaced by the grease wood (*sarcobatus vermiculatus*). Wide, bare, path-like intervals surround the bushes, or the spaces are occupied by scanty grass, which formerly furnished food to the buffalo, now become extinct in this region and elsewhere west of the Rocky Mountains.

The fossils for the most part are derived from the more superficial deposits of the great Uintah basin, which Prof. Hayden has distinguished as the Bridger group of beds. These compose the terraces or table lands in the neighborhood of Fort Bridger, and consist of nearly horizontal strata of variously colored, indurated clays and sandstones. As the beds wear away, through atmospheric agencies, on the naked declivities of the flat-topped hills, the fossils become exposed to view, and tumble down to the base of the hills, among the crumbling *debris* of the beds.

The flat-topped hills or terraces of the Bridger basin, rising from broad valleys and extended plains, form the most conspicuous objects of the landscape. A similar condition of the country, alternating with boundless plains and great mountain heights, forms a characteristic feature of a great part of the region west of the Mississippi.

The flat-topped hills, table-lands, bench-lands, or terraces, as they are variously named, seen from lower levels, are usually called "buttes," especially when they are of limited extent. The name is of French origin, and signifies a bank of earth or rising ground. The name is likewise applied in a more restricted sense, to the prominent irregularities of the deeply eroded and naked declivities of the more extended terraces. The buttes, therefore, vary in extent from a mere mound, rising slightly above the level of the plains, to hills of varied configuration, reaching to the level of the broader buttes or terraces. In the course of ages, the wearing away of these has been enormous, and still continues under the usual atmospheric agencies, while the detritus is spread out on the plains below.

From the lower plains, the neighboring terraces, when of circumscribed extent, appear like vast earthwork fortifications, and when evenly preserved on the declivities for a considerable distance, reminds one of long railway embankments. Frequently the terraces are so eroded and traversed by narrow ravines, that they appear as great groups of naked buttes rising from the midst of the plain, or assembled around the horizon, closely facing and flanking the more distant and extended lands, as if to protect them. Nothing can be more desolate in appearance than some of these vast assemblages of crumbling buttes, destitute of vegetation and traversed by ravines, in which the water-courses in mid-summer are almost all completely dried. To these assemblages of naked buttes, often worn into castellated and fantastic forms, and extending through miles and miles of territory, the early Canadian voyagers gave the name of "Mauvaises Terres." They occur in many localities of the Tertiary formations west of the Mississippi river.

In wandering through the "Mauvaises Terres," or "Bad Lands," it requires but little stretch of the imagination to think oneself in the streets of some vast ruined and deserted city. No scene ever impressed the writer more strongly than the view of one of these Bad Lands. In company with his friends, Drs. Carter and Carson, he made an expedition, in search of fossils, to Dry Creek Cañon, about forty miles to the southeast of Fort Bridger. The cañon, or valley, is bounded by high buttes, and contains a meadow of rushes, traversed by a stream which is liable to be dried up in the latter part of the summer, whence the name of the cañon. On ascending the butte to the east of our camp, I found before me another valley, a treeless, barren plain, probably ten miles in width. From the far side of this valley, butte after butte arose and grouped themselves along the horizon, and looked together in the distance like the huge, fortified city of a giant race. The utter desolation of the scene, the dried up water-courses, the absence of any moving object, and the profound silence which prevailed produced a feeling that was positively oppressive. When I then thought of the buttes beneath my feet, with their entombed remains of multitudes of animals forever extinct, and reflected upon the time when the country teemed with life, I truly felt that I was standing on the wreck of a former world.

The buttes are often especially designated from some supposed resemblance, or other character, as Church Butte, Pilot Butte, Grizzly Butte, etc.

As before intimated, the more superficial table-lands of the Bridger basin, as they appear in the vicinity of Fort Bridger, are composed of nearly horizontal strata of various colored, indurated clays and sandstones. In most localities visited by the writer the clays predominate, and are usually greenish, grayish, ash-colored, and brownish. When unexposed they are compact, homogeneous, and of stony hardness. In composition they vary from nearly pure clay to such as are highly arenaceous, and gradate into those in which sand largely predominates, and they usually contain few or no pebbles. They appear to be more or less fissured, and break with an irregular and somewhat conchoidal fracture. Exposed to atmospheric agencies, moisture and frosts, they readily disintegrate, and the declivities of the buttes, generally entirely destitute of vegetation, are usually invested with crumbling material from a few inches to a foot or more in depth. When this loose material is wet it forms a tenacious mud, and along the course of streams in the ravines, the deepest and most treacherous mire. Baked by the sun upon the plains, it fixes the drift pebbles and other stones as firmly almost as if imbedded in mortar.

In some localities the clays of the buttes abound in fresh water shells, as Unio, Melania, Planorbis, etc. Less frequently in other places they contain land-shells, as Helix, etc.

The sandstones are more frequently of various shades of green, but are also yellowish, and pass into shades of brown. They are compact and hard when unexposed to the weather, and are usually fine-grained, but also occur of a gravelly constitution. They are fissured in comparatively large masses, which assume a rounded form as they are worn away, so that a ledge of sandstone projecting from the declivity of a butte will appear like a row of cotton bales. As they disintegrate less rapidly than the contiguous clays, masses are often observed resting upon cones and columns of the latter, contributing greatly to the picturesque and sometimes fantastic appearance of the buttes.

Many of the table-lands and lesser buttes in the vicinity of the Uintah Mountains are thickly covered with drift from the latter, consisting of gravel and bowlders, of red and gray, compact sandstones, or quartzites. The drift material is usually firmly embedded in the surface of the plains, so as to appear like a pavement. The bowlders are generally small, but assume larger proportions, approaching the

Uintahs. In many cases the drift completely covers the terraces or buttes, descending upon the declivities so as entirely to conceal their structure. Usually, however, it accumulates in the ravines of the declivities, leaving bare the intervening ridges of light-colored clays and sandstones. Many of the buttes are nearly or quite free of drift material; some again are strewn with fragments of rocks, consisting of the harder materials from the terraces themselves, and these likewise occur mingled with the drift-pebbles and bowlders from the mountain heights.

The stone fragments from the buttes consist of harder siliceous and calcareous clays, impure limestones, jaspers, and less frequently agate and chalcedony. In some instances they consist of singularly black, incrustated and rounded sandstones, somewhat of the character of the septaria. Specimens of these occasionally bear a resemblance to fossil turtles, and when found with the harder crust broken, they look like turtle-shells filled with a sandstone matrix.

In the buttes in the vicinity of Carter Station, on the Union Pacific Railroad, I observed many large nodular and cylindroid masses of agate. These have a concentric arrangement of layers resembling that of fossil wood, for which they are taken. Many of the masses contain a nucleus of amber-colored crystals of calcite.

Nodules of chalcedony, with dendritic markings, occur in some of the buttes. These, together with the condition of many of the fossils of the buttes, indicate the presence of a considerable proportion of soluble silica in the waters of the ancient lake. In some of the sandstones the fossil shells have had their lime completely replaced by clear chalcedony.

Occasionally, strata of limestone, mostly impure, from the admixture of clay and sand, are found in some of the buttes. A frequent constituent also is fibrous arragonite, or satin spar, in thin seams. Many of the bare mounds of clay among the buttes are thickly strewn with fragments of this arragonite.

The stones imbedded in the surface of the plains and buttes, in some positions favorable for the purpose, are highly polished from the conjoined action of the wind and sand, and when seen in the slanting light of the early morning or evening sun, appear like myriads of scattered mirrors. In many positions the stones, no matter what may be their composition, are all blackened. The phenomena I could not explain.

In many places the stone fragments from the declivities of the terraces, strewn over the lower buttes, or distributed over the plains, are splintered or flaked in a remarkable manner. The jaspers, especially, are often broken in such a way that they appear as spawls from rude implements of art, or even resemble the latter. Some of them are certainly the work of primitive man, but the vast proportion, often scattered over miles of surface, are probably accidental forms. These I suppose to have been produced by stones striking one another in the descent from declivities, as they have been carried down, perhaps, by glacial movement. The softer rocks of the buttes, those which are too soft for stone works of art, are also observed broken in the same way as the hard ones. In experimenting on some large splintered slabs of jasper, from the buttes of Dry Creek Canon, I found that a quick blow of a hammer would send off, with a ringing sound, a long, sharp flake, reminding me of the primitive knives or scrapers of the stone age of man.

Between the well finished implement and the accidental spawl every gradation of form may be observed among the scattered stones of the plains and buttes.

Many of the accidental forms, as well as those more nearly resembling artificial implements, if they are not actually such, appear greatly to differ in age. Some of the specimens are as sharp and fresh in appearance as if but recently shivered from the parent block, while others are so much worn and so deeply altered from exposure, that they look to be of ancient date. In some of these old looking specimens, the jasper, originally brown or black, has become dull white and yellow, the depth of one fourth of an inch from the surface.

[In this relation I may take the opportunity to refer to one of the simplest of stone implements still in use, and which, if it had alone been found among the flaked materials of the buttes, would certainly have been viewed as an accidental spawl. During my stay at Fort Bridger the Shoshone Indians made a visit to the post, and encamped in its vicinity for a week. Being the first time I had an opportunity of seeing a tribe of Indians, I felt much interest in observing them. While wandering through their camp I noticed the women dressing buffalo-skins with a stone implement, the only one of this material I found in use among them. A serrated scraper of iron was also employed, but the stone implement was clearly a common and important one. It was a spawl from a quartzite bowlder, made by a single smart blow with another stone. It is circular, or oval, plano-convex, and with a sharp edge. The implement, according to Dr. Carter, who is quite familiar with the language and habits of the Shoshones, is called by them a "teshoa." By a happy accident I learned that it was not a mere recent instrument, incidental to the time and place. While on an excursion after fossils, in company with Dr. Carter, I noticed on the side of a butte a few weathered human bones, to which I directed the attention of my friend. On further examination we found others, together with some perforated canines of the elk, and one of the identical "teshoa," above described. Dr. Carter observed that the Shoshones sometimes buried their dead upon the top of prominent buttes, and these remains had fallen from the grave of a squaw, which, in the course of time, had become exposed by the wearing away of the edge of the butte. The bones and elk-tusks were much weathered. Their appearance, and the probable circumstance that several years had elapsed before the butte could wear away to reach the grave, appear to be sufficient evidence that the "teshoa" was an implement of common use.]

As the clays and sandstones of the Bridger terraces and buttes crumble away, a variety of remains of terrestrial and fresh water animals are exposed to view. In some of the buttes they are comparatively abundant; in others, they are rare. The fossils consist of the bones and teeth of vertebrates, and the shells of molluscs. Fragments of silicified wood also occur, though not frequently. Shells of the sandstones are composed of chalcedony; but those imbedded in the indurated clays usually retain their carbonate of lime.

The fossil bones are completely petrified; that is to say, their more perishable constituents have been replaced mainly by silicious matter. They are frequently as black as ebony; and the teeth are usually black, with the enamel highly lustrous. Often they are brownish, with a greenish aspect, derived from the greenish matrix in which they were imbedded. They are also found of a yellowish clay color and duller aspect.

Many of the bones are more or less crushed and distorted, as a result of the pressure of the superincumbent strata. The fragments are generally but slightly dislocated, showing that the crushing occurred while they were imbedded. The stronger bones are often well preserved, especially the rami of lower jaws and teeth, and the smaller bones of the wrist and ankle. Whole skulls are exceedingly rare, and when discovered are much crushed and distorted. Turtle shells are among the most frequent fossils, but are usually more or less fractured, crushed and distorted. In searching over the buttes, little piles of bone fragments are often seen diverging from a prominent point; these, on examination, generally prove to be the remains of a turtle shell, which, after exposure, has fallen to pieces.

Generally the fossils are sharply preserved; that is to say, they rarely have a rolled or water-worn appearance, indicating that bones and shells were soon enveloped in mud at the bottom of comparatively quiet water. In the gravelly strata rolled fragments of bones are found.

Nearly all the fossils collected from the Bridger beds have been collected as loose specimens, picked up on the surface of the buttes. No excavations have been made into the latter in search of fossils, except to exhume a partially exposed bone, or some parts of a skeleton supposed to be contiguous to specimens lying in view on the surface. Usually only a few pieces of a skeleton have been found together, and in no instance has a complete one been discovered which has been brought to my notice. Generally, too, there has been no certainty that bones or fragments found together belonged to the same skeleton, and in most instances they have appeared to belong to several different animals.

The remains of vertebrates thus far discovered, in the Bridger Tertiary formation, represent all classes, except Batrachians, and these, no doubt, formed members of the ancient fauna; but their delicate bones have, as yet, escaped detection.

The remains of mammals are especially numerous, and they belong to many genera, most of which are extinct, and had not been previously described or found elsewhere. The greater proportion of the mammals were odd-toed pachyderms, whose nearest living allies are the tapirs. Proboscidian and equine forms appear to have been sparsely represented. Even-toed pachyderms were comparatively few; and ruminants, whose remains are so abundant and varied in the later Tertiary formations east of the Rocky Mountains, appear to have been absent. The other remains of mammals belong to rodents, insectivores, and carnivores, nearly all of extinct genera, not previously described, nor found in other localities. Primates, bats, marsupials, and edentates, are probably represented, but have not been certainly recognized among the fossils which I have had the opportunity of examining. The nature of the formation from which the remains are obtained is such, that we do not expect to find evidences of the remaining orders of mammals.

No remains of birds have come under my notice; but Professor Marsh, who has explored the Bridger Tertiary beds with unusual facilities and great diligence, has reported the discovery of specimens which he attributes to half a dozen species of two extinct and previously unknown genera.

Of reptiles, the remains of turtles are, perhaps, the most abundant fossils met with in the buttes of the Bridger basin. They belong to a number of different genera, several of which are extinct, but others belong to genera still in existence. Most of them are aquatic forms, but one, at least, was a land tortoise. The number of species and genera is in striking contrast with the single species, represented by a multitude of individuals in the Tertiary deposits of White river, Dakota, and Niobrara river, Nebraska.

The turtle remains mostly consist of the shells, often nearly complete, and sometimes including other bones of the skeleton imbedded in the interior matrix.

The remains of crocodiles, which are entirely wanting in the White river and Niobrara Tertiaries just mentioned, are frequent in the Bridger beds, and represent several species.

Remains of lizards also, allied to the modern iguana and monitor, are found as associates of the Bridger fauna.

Professor Marsh has likewise reported the discovery of remains of serpents, which he ascribes to several species and genera.

Multitudes of well preserved fresh water fishes are found in the Green river shales. They are chiefly cyprinodonts and herrings, and, for the most part, have been described by Professor Cope.

Black, shining, enameled scales, teeth, and vertebræ of ganoid fishes are frequent among the fossils of the Bridger beds.

The Tertiary strata of Green river and its tributaries, including the latter, as indicated by the character of the vertebrate fossils, are much older than the tertiaries of the Mauvaises Terres of White river, Dakota, and of the Niobrara river, Nebraska. They overlie the cretaceous rocks, with which they are unconformable, and they are probably contemporaneous with the Eocene formations of Europe.

The Earth Works at Fort Ancient.

On Tuesday, the 23d day of June, 1874, the Cincinnati Society of Natural History made an excursion to Fort Ancient, to view some of the ruins of great earthworks, constructed by an unknown race of people, whom the archæologists call the Mound Builders.

A special car was chartered for the occasion, and at 9 o'clock, A.M., it left the depot of the Little Miami Railroad, and arrived at Fort Ancient about 11 o'clock. The distance is forty-two miles.

The company consisted of Dr. W. H. Mussey, Dr. Gustav Bruehl, U. P. James, Dr. C. A. Miller, Dr. H. H. Hill, wife and the Misses Hill, Dr. J. L. Dryer, Dr. R. M. Byrnes and wife, R. B. Moore, wife and ladies, L. S. Cotton, wife and ladies, Paul Mohr, Jr., and the

Misses Mohr, J. A. Williams and wife, Miss M. Montfort, S. A. Miller and wife, and others, amounting in all to about fifty persons. The company met at Fort Ancient J. Kelly O'Neil, Dr. Scoville, from Lebanon, and others.

The train stopped on arriving at the west end of the fortifications, about a mile from the station, and let the party off to ascend a very steep hill, two hundred and thirty feet high, densely covered with undergrowth and briars. The day was quite warm, which was another obstacle in the way of a pleasant ascent to the top of the hill. But the enthusiasm was great, and in a short time these difficulties were overcome, and the whole party were within or seated upon the earthworks which at this point are from ten to twenty feet high. Here the party dispersed to pursue their separate plans for pleasure and instruction. Some hunted land shells, some botanical specimens, and others followed the meandering course of the earthworks, and speculated upon the people that constructed them, whence they came and whither they went; what they were constructed for, and whether or not they were ever completed, and served the purpose for which they were constructed. The collections were displayed, and the speculations delivered while the party constituted a picnic under the large beech trees at the east end of the earthworks, on the old Lebanon and Chillicothe pike. Here, near the east end of the works, resides a clever farmer, from whose well we obtained plenty of cool water. He seemed to be of the opinion that the earthworks were constructed by the Jews, about the time of Jesus Christ, and there are many other persons whose opinions are about as lucid.

Since Prof. Locke made the survey of these earthworks in 1843, some changes in the grounds have occurred, and a few discoveries have been made, though we are but little better informed in regard to the works than we were then. A large field has recently been cleared within the west fortification, which is now cultivated in corn, and some additional clearing has been made in the east fortification, but the most of the ground is covered with dense undergrowth and briars, making it difficult to examine and survey the whole fortification.

Prof. Locke describes the works as follows: "This work occupies a terrace on the left bank of the river, and two hundred and thirty feet above its waters. The place is naturally a strong one, being a peninsula, defended by two ravines, which, originating on the east side, near to each other, diverging and sweeping around, enter the Miami, the one above, the other below the work. The Miami itself, with its precipitous bank of two hundred feet, defends the western side. The ravines are occupied by small streams. Quite around this peninsula, on the very verge of the ravines, has been raised an embankment of unusual height and perfection. Meandering around the spurs, and reëntering to pass the heads of the gullies, it is so winding in its course that it required one hundred and ninety-six stations to complete its survey. The whole circuit of the work is between four and five miles. The number of cubic yards of excavation may be approximately estimated at six hundred and twenty-eight thousand eight hundred. The embankment stands in many places twenty feet in perpendicular height; and, although composed of a tough, diluvial clay, without stone, except in a few places, its outward slope is from thirty-five to forty-three degrees. This work presents no continuous ditch; but the earth for its construction has been dug from convenient pits, which are still quite deep, or filled with mud and water. Although I brought over a party of a dozen active, young engineers, and we had encamped upon the ground to expedite our labors, we were still two days in completing our survey, which, with good instruments, was conducted with all possible accuracy. The work approaches nowhere within many feet of the river; but its embankment is, in several places, carried down into ravines, from fifty to one hundred feet deep, and at an angle of thirty degrees, crossing a streamlet at the bottom, which, by showers, must often swell to a powerful torrent. But, in all instances, the embankment may be traced to within three to eight feet of the stream. Hence, it appears that although these little streams have cut their channels through fifty to one hundred feet of thin, horizontal layers of blue limestone, interstratified with indurated clay-marl, not more than three feet of that excavation has been done since the construction of the earthworks. If the first position of the denudation was not more rapid than the last, a period of at least thirty to fifty thousand years would be required for the present point of its progress. But the quantity of material removed from such a ravine is as the square of its depth, which would render the last part of its denudation much slower, in vertical descent, than the first part. That our streams have not yet reached their ultimate level, a point beyond which they cease to act upon their beds, is evident from the vast quantity of solid material transported annually by our rivers, to be added to the great delta of the Mississippi. Finally, I am astonished to see a work simply of earth, after braving the storms of thousands of years, still so entire and well marked. Several circumstances have contributed to this: the clay of which it is built is not easily penetrated by water; the bank has been, and is still, mostly covered by a forest of beech trees, which have woven a strong web of their roots over its steep sides; and a fine bed of moss (*Polytrichum*) serves still further to afford protection."

The embankment may be characterized as broken up in short pieces, for every one or two hundred feet there is an opening through it, and situated upon the extreme margin of the steep hill-sides, winding and twisting about the heads of gullies, and projecting peaks of the hill, as formed by the erosive powers of the atmosphere, the storms, and other natural causes, except where it crosses the plain at the northeastern part of the fortification. Here there are openings about every two hundred feet, and the embankment is very high, even now near twenty feet, though the ground was cleared before Prof. Locke made his survey in 1843.

The mounds that were once so conspicuous within the eastern fortification have been plowed down, until they rise but very little above the level of the surrounding plain, and will not be noticed by the casual observer unless directly pointed out.

Two mounds are situated a short distance south of the eastern part of the fortification, between which the old Lebanon and Chillicothe pike is located. These mounds show the effects of the powerful denuding agencies in the atmosphere. They have been cleared for many years, and are now very much flattened, appearing to be less than ten feet higher than the pike, though it is likely they were once as high, or even higher, than the embankment of the fortification. It is said that a pavement of thin limestones has been discovered a foot or more below the surface of the ground, and extending several hundred yards in a southeast direction from these mounds, and I saw in the field near by many of these flat stones that had been plowed up, and upon digging a foot or more in depth at this place found the pavement, and lifted up some of the thin, badly weather-worn stone, which had evidently been placed where found, because the diluvial soil and drift was several feet thick below them. The excavation and work at this place was under the direction of Mr. Hosea and J. Kelly O'Neil, who were fully satisfied that they were lifting up the pavement laid by the subjects of the king of the "Mound Builders," anywhere from ten to five hundred thousand years ago, as it best suits the imagination, always being willing to rise or fall a peg or two to suit the taste of the inquisitor.

A ditch runs east and west, in a line with these mounds, west of the pike, and a few hundred feet south of the fortification, the purpose of which belongs to that department of archæological hermeneutics yet unexplored. A few acres of ground surrounding these mounds is said to be remarkably rich and productive, and from the dark and alluvial appearance, one naturally comes to the conclusion "that here the stock was kept, or the offal deposited in such quantities that time has failed to carry away the spongy mould arising from decaying vegetable and animal matter.

No doubt many exceedingly interesting and important discoveries will be made in the future, tending to throw light on the objects and purposes of this wonderful construction. All that we can at present assume as an absolute certainty is, that it is the work of intelligent man. Investigation, thus far, has not gone beyond the surface of the ground, and the presence of wells and cisterns, or of pavements, can only be ascertained by excavation.

Any one examining these works must come to the conclusion that they were erected for defense, and that by a race of men who understood something of the art of war; indeed, much more than can be reasonably attributed to the roving propensities and unstable habits of the American Indian aborigines found upon the continent by the first discoverers of this country. The extent, too, of these works, viewed in the light of military fortifications, proves beyond peradventure that they were raised not for the protection of a tribe more or less numerous, but of a powerful people, raised to war and used to war's alarms; for within these formidable lines there might be congregated, at a moment's notice, fifty or sixty thousand men, with all their materials of war, women, children, and household goods. The Roman legion, we are told, required only a square of seven hundred yards to effect the strongest encampment known to the ancients of Europe and Asia, so that, upon a similar basis, the investment of these fortifications must have been the work of a very formidable body of men indeed, and such as we read of only in the great wars of the Roman emperors with the barbarous hordes that swept from the North, or the masses that were hurled upon each other in the days of the first crusades. The supposition that the works were of a military character, seems to me not only to be the most probable, but the only one, in the absence of any clue, history or tradition, in the minds of the aborigines, that can be reached.

The openings, visible at intervals of one hundred and two hundred feet, and which pass through the embankment, may have been protected with gates, or movable timbers, for the purpose of closing them at night, or in times of apprehended danger. We can readily conceive how these embankments might have been thrown up around the city or town in which the chief administrative officer of the nation resided, to guard against sudden attacks and surprises on the part of the neighboring peoples. But whatever conclusion may be arrived at, upon the mere surface evidence, must be undoubtedly greatly modified by further research, and it is to me a matter of surprise that so singular and interesting a subject in the midst of a populous and inquisitive people, and only an hour's ride from a large and flourishing city, has not hitherto received a greater measure of investigation.

Notice of Modiolopsis pholadiformis (Foster and Whitney).

Since writing the preceding monograph, I found, at Richmond, Indiana, the cast of a modiolopsis, having a small part of the shell near the hinge line, which shows strong folds or ribs starting from the hinge line toward its base, and I believe it is most likely that it is Foster and Whitney's Lake Superior species, *Modiolopsis pholadiformis,* which they describe as follows:

"Shell oval obovate, elongate; base slightly arcuate in the middle; convex in the middle and compressed toward the posterior extremity; umbones prominent, hinge line slightly arched, and in some specimens nearly straight; muscular impression, large and strong, near the anterior extremity; surface marked by strong folds or ribs, which, originating on the hinge line, diverge and curve gradually downward to the base."

The strata at Richmond, Indiana, are the equivalent of the rocks on the shore of Little Bay des Noquets, where Foster and Whitney procured their specimens. Beside the strong ribs starting from the hinge line toward the base is a peculiar and remarkable feature, which indicates with almost unmistakable certainty that our specimen belongs to this species. The subject, however, will bear farther investigation, and if it shall appear that our specimen does not belong to this species, then it will belong to an undescribed species.

People who have no Idea of a Supreme Power.

There is a general impression that all tribes of people have possessed some idea of a Supreme Power, that guides and directs all things. But this is a mistake. There are many tribes of people even now that have no notions upon the subject, as will appear from the following extract from Sir John Lubbock's work on prehistoric times:

"According to Spix and Martius, Bates and Wallace, some of the

Brazilian Indians were entirely without religion. Burmeister confirms this statement, and, in the list of the principal tribes of the valley of the Amazons, published by the Hakluyt Society, the Chunchos are stated 'to have no religion whatever,' and we are told that the Curetus 'have no idea of a Supreme Being.' The Toupinambas of Brazil had no religion. The South American Indians of the Gran Chaco are said by the missionaries to have 'no religion or idolatrous belief or worship whatever; neither do they possess any idea of God, or of a Supreme Being. They make no distinction between right and wrong, and have, therefore, neither fear nor hope of any present or future punishment or reward, nor any mysterious terror of some supernatural power, whom they might seek to assuage by sacrifices or superstitious rites.' Bates tells us 'that none of the tribes on the upper Amazons have any idea of a Supreme Being, and consequently have no word to express it in their languages.' Azara also makes the same statement, as regards many of the South American tribes visited by him.

"Father Baegert, who lived as a missionary among the Indians of California for seventeen years, affirms that 'idols, temples, religious worship, or ceremonies, were unknown to them, and they neither believed in the true and only God, nor adored false deities,' and M. de la Perouse also says that they 'had no knowledge of a God, or of a future state.' Colden, who had ample means of judging, assures us that the celebrated 'five nations,' of Canada, 'had no public worship, nor any word for God,' and Hearne, who lived among the North American Indians for years, and was perfectly acquainted with their habits and language, says the same of some tribes on Hudson's Bay.

In the voyage of the *Astrolabe*, it is stated that the natives of the Samoan and Solomon Islands, in the Pacific, had no religion, and in the voyage of the *Novara*, the same is said of the Caroline Islanders. The Samoans, have neither moraes, nor temples, nor altars, nor offerings, and consequently none of the sanguinary rites observed at the other groups. In consequence of this the Samoans were considered an impious race, and their impiety became proverbial with the people of Rarotonga, for, when upbraiding a person who neglected the worship of the gods, they would call him "a godless Samoan." On Damood Island, between Australia and New Guinea, Jukes could find no "traces of any religious belief or observance." Duradawan, a Sepoy, who lived sometime with the Andaman Islanders, maintained that they had no religion, and Dr. Mouatt believes his statements to be correct. Some of the Australian tribes also are said to have no religion. In the Pellew Islands, Wilson found no religious buildings, nor any sign of religion.

Mr. Wallace, who had excellent opportunities for judging, and whose merits as an observer no one can question, tells us, that among the people of Wanumbia, in the Aru islands, he could find no trace of a religion; adding, however, that he was but a short time among them.

The Yenadies and the Villees, according to Dr. Shortt, are entirely without any belief in a future state, and again, Hooker tells us that the Lepchas of Northern India have no religion. Captain Grant could find "no distinct form of religion" in some of the comparatively civilized tribes visited by him. According to Burchell, the Bachapins (Caffres) had no form of worship or religion. They thought that everything made itself, and that trees and herbage grew by their own will. They had no belief in a good deity, but some vague idea of an evil being. Indeed, the first idea of a god is almost always as an evil spirit.

Speaking of the Foulahs of Wassoulo, in Central Africa, Caillie states: "I tried to discover whether they had any religion of their own; whether they worshiped fetishes, or the sun, moon, or stars; but I could never perceive any religious ceremony among them." Again, he says of the Bambaras, that, "like the people of Wassoulo, they have no religion," adding, however, "that they have great faith in charms."

Burton also states, that some of the tribes in the lake districts of Central Africa "admit neither God, nor angel, nor devil." Livingstone mentions that on one occasion, after talking to a Bushman for some time, as he supposed, about the Deity, he found that the savage thought he was speaking about Sekomi, the principal chief of the district.

Speaking of the Esquimaux, Ross says: "Ervick being the senior of the first party that came on board, was judged to be the most proper person to question on the subject of religion, I directed Sacheuse to ask him if he had any knowledge of a Supreme Being, but after trying every word used in his own language to express it, he could not make him understand what he meant. It was distinctly ascertained that he did not worship the sun, moon, stars, or any image or living creature. When asked what the sun or moon was for, he said, to give light. He had no knowledge or idea how he came into being, or of a future state; but said that when he died he would be put into the ground. Having fully ascertained that he had no idea of a beneficent Supreme Being, I proceeded through Sacheuse to inquire if he believed in an evil spirit, but he could not be made to understand what it meant. He was positive that in this incantation he did not receive assistance from anything, nor could he be made to understand what a good or an evil spirit meant.

In some cases travelers have arrived at these views very much to their own astonishment. Thus, Father Dobritzhoffer says: "Theologians agree in denying that any man in possession of his reason can, without a crime, remain ignorant of God for any length of time. This opinion I warmly defended in the University of Cordoba, where I finished the four years' course of theology begun at Gratz, in Styria. But what was my astonishment, when, on removing from thence to a colony of Abipones, I found that the whole language of these savages does not contain a single word which expresses God or a divinity. To instruct them in religion it was necessary to borrow the Spanish word for God, and insert into the catechism, 'Dios ecnam caogerik,' 'God, the Creator of things.'"

Those who assert that even the lowest savages believe in a Supreme Deity, affirm that which is entirely contrary to the evidence. The direct testimony of travelers on this point is indirectly corroborated by their other statements. How, for instance, can a people who are unable to count their own fingers, possibly raise their mind so far as to admit even the rudiments of a religion? Again, fetish worship, which is so widely prevalent in Africa, can hardly be called a religion. And when the missionaries introduced a printing press into the Feegee, "the heathen at once declared it to be a god."

Glossary of a few Palæontological Terms, the Accent and Pronunciation of which are not obvious. By PROF. E. W. CLAYPOLE, of Antioch College.

I.—BRACHIOPODA.

ATHYRIS—Sig., *without a door.* Ety., Greek *α*, *not* or *no*, and *θυρίς*, *a small door* or *window*, in allusion to the deltidium which, in this genus, is obsolete.

PENTAMERUS.—Sig., *five parted.* Ety., Greek *πεντε*, *five*, and *μεροσ*, *a part*, in allusion to the fifth small chamber occurring in the central part of the shell.

ATRYPA.—Sig., *without foramen.* Ety., Greek *α*, *not* or *no*, and *τρυπα*, *an opening.* It is not easy to see why this name was given, as the foramen is present in the species of this genus. It is one of Dalman's terms. Woodward, speaking of it, says: "The term 'atrypa,' *like all Dalman's names*, is objectionable."

STROPHOMÉNA.—Sig., *a bent crescent.* Ety., Greek στροφέ, *a turning,* and μένέ, *a crescent,* in allusion to the bending of the valves to one side or the other, as the shells reach full size. This term has almost completely superseded Dalman's Leptœna (finely striated), though, in some respects, with doubtful advantage in point of etymology.

CRANIA.—Sig., *like a skull.* Ety., Greek κρανίον, *the upper part of a skull,* from its resemblance. The pronunciation, crā'nia, is sometimes defended on the ground that the Greek word for a skull is κρανίον, and that the usual adjective form derived from it does not exist. But it is not unusual to form an adjective in coining new scientific terms from the Greek, if such adjective be not already in existence, and then to use it as a generic or specific name. Retzius, the Swedish naturalist, in giving the name, would have used *cranion,* or *cranium* (the Latin form), itself, and not the plural *crania,* had he intended to employ the noun. Moreover, it is the rule to employ adjectives in the feminine gender, when they are used as generic names in conchology, as they are understood to agree with the word *concha.*

CALCEOLA.—Sig., *a little shoe.* Ety., Latin *calceolus,* diminutive of (*calceus*) *a shoe;* alluding to the form of *Cálcĕŏla sandalĭna,* the type of the genus.

DISCINA.—Sig., *disclike.* Ety., *discus, a flat round plate,* and the adjective termination, *ĭnus,* implying *resemblance* or *affinity.*

OBOLUS.—Sig., *a small round disc.* Ety., Greek ὀβολος, *a small coin.*

DELTHYRIS.—Sig., *with triangular foramen.* Ety., Greek δελτα, *a letter in the form of a triangle,* and θυρις, *a doorway.* Dalman's synonym for the genus *Spirifera* of Sowerby.

TRIGONOTRÉTA.—Sig., *with pierced deltidium.* Ety., Greek τριγόνον, *a triangle,* and τρετος, *pierced.* König's synonym for *Spirifera.*

UNCITES.—Sig., *hooked.* Ety., Latin *uncus, a hook,* and Greek affix ιτες, implying *possession* or *resemblance.* This term, like many others, is a hybrid, but takes in common with others similarly formed the accent and quantity of its Greek termination.

CHONETES.—Sig., *like a funnel.* Ety., Greek χονε, *a small funnel.*

The numerous compounds of the Greek word θυρις, *a small doorway,* should all be pronounced with the "y" short, and the accent on the preceding syllable, as *Hypóthyris,* "having a foramen below," (*i. e.*) the beak. *Heméthyris,* "having half a foramen." *Acanthóthyris,* "having a foramen beset with spines."

On the other hand all compounds of the Greek word τρυπα, *a foramen,* should be pronounced with the "y" long, and accented as *atrypa.*

REVIEWS AND BOOK NOTICES.

Professor Meek, in a series of critical articles in the American Journal of Science and Arts, commencing in March of the present year, has reviewed many of the fossil species figured and described in the fifth volume of the Geological Survey of Illinois.

He suggests that *Actinocrinites delicatus* and *A. penicillus*, pl. viii., fig. 2, are probably the young of the genus *Strotocrinus*, which latter genus holds a higher position in the scale of development than the former. That the genus *Zeacrinus* (Troost) is probably only a synonym of *Hydreionocrinus* (Koninck). That *Fusilina gracilis* and *F. ventricosa*, pl. xxiv., figs. 7, 8, are only varieties of *F. cylindrica*. That *Aviculopecten neglectus* (Geinitz), pl. xxvi., fig. 7*a*, *b*, *c*, *d*, should be placed in a new genus. He, therefore, proposes to write the name *Euchondria neglecta* (Meek). That fig. 8, pl. xxvi., is an *Aviculopecten carboniferus* (Stevens), instead of *Nucula parva*, as stated by mistake.

His criticisms upon the crinoidea are the reflections of a learned paleontologist, and must be studied in connection with said fifth volume, in order to be fully appreciated.

The legislature of Ohio, about the close of the last session, provided for publishing two more volumes of the Geological Survey. The statutory provision is as follows:

"For preparing for publication, engraving, printing, binding, and publishing parts one and two of the second volume of the report of the Geological Survey of the State, sixty thousand dollars, to be expended under the direction and supervision of the supervisor of printing and secretary of state; and the secretary of state is hereby authorized to purchase a sufficient supply of super-royal paper to provide fly-leaves for said volumes; two of said reports, to be paid for out of this appropriation."

It is to be hoped that the work will be very carefully prepared.

We have received a copy of "Guyot's Grammar School Geography," just published. It contains numerous maps, very carefully prepared and neatly executed, presenting a better view of the geography of the surface of the earth than is to be found in any atlas of equal size yet published. It contains also a vast amount of information not readily obtainable elsewhere, and, taken all in all, is a school geography of inestimable value, and one that we do not hesitate to recommend for general use in the higher grades of public schools. Published by Scribner, Armstrong & Co., of New York, at $2. C. B. Ruggles, agent for Ohio, Kentucky, and Tennessee, care of Geo. E. Stevens & Co., 39 West Fourth street, Cincinnati, Ohio.

Also, a copy of "Guyot's Physical Geography," containing 24 maps and many illustrations. The maps show the lines of equal magnetic declination, distribution of volcanoes and earthquakes, structure of the several continents, marine currents, isothermal lines, winds, rains, distribution of vegetation, and of useful minerals and the races of men, and other valuable meteorological and physical phenomena. They are alone worth much more than the cost of the book to the student or the naturalist. The book contains useful information relating to the formation and drainage of rivers and lakes, the results of oceanic movements, the distribution of heat, circulation and phenomena of the atmosphere, and other matters affecting the geographical surface of the earth, which every student should comprehend before leaving school, but the book will nevertheless always be quite handy to have about a library. Published and for sale same as last.

"Land and Fresh Water Shells of Lasalle Co., Illinois," is the title of a pamphlet of 48 pp., by W. W. Calkins, Esq., of Chicago, Illinois. The pamphlet contains descriptions of about one hundred species, and one plate, upon which is figured *Helix albolabris*, *H. clausa*, *H. multilineata*, *H. profunda*, *H. Pennsylvanica*, *H. alternata*, *H. solitaria*, *Succinea obliqua*, *Hy. lineata* and *Try. Lewisii*. It is a local monograph very creditable to the author, and may be procured by application to him. Price, one dollar.

We have received the advance sheets from the Report of the Bureau of Agriculture of Tennessee, relating to the Coal and Iron of that State, from J. W. Newman, Esq. It flatters the prospects of the future mining interests of that State. The report can be procured of J. B. Killebrew, Secretary of the Bureau of Agriculture, Nashville, Tennessee.

We are indebted to the Hon. H. B. Banning for "Mineral Resources West of the Rocky Mountains, 1873;" "Geological Survey of Montana, Idaho, Wyoming, and Utah, 1872;" "Contributions to the Extinct Vertebrate Fauna of the Western Territories, by Joseph Leidy," and "Synopsis of the *Acrididæ* of North America, by Cyrus Thomas Ph. D."

We take pleasure in calling the attention of every person interested in educational matters to the advertisement of the unparalleled series of school books, published by Wilson, Hinkle & Co., of this city. Their text-books are in general use in all schools, public and private, throughout this section of country, and the rapid progress of the scholars and high standing of the schools is traceable directly to the unequaled merit of these works.

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Some Facts and Considerations about Fort Ancient, Warren County, Ohio. By L. M. HOSEA, Esq.

Archæology, which, as has been well said by Sir John Lubbock, is the link between geology and history, has of late years assumed an importance in the scientific world second to no other branch of investigation. In various quarters the mists hitherto enshrouding the early history and condition of mankind seem to be breaking away, and we may hope at some day to be able to trace back the devious line of struggling humanity to where it first emerges from absolute barbarism, or possibly from a lower scale of physical being, unless our investigations ultimately lead us to a higher state of primitive civilization from which the rude condition of the stone age was a degradation. Although a science yet in its infancy, it has borne fruits of no mean importance, as we must admit when we consider the investigations of Dr. Schliemann, upon the site of ancient Troy; of Mr. George Smith, in Assyria; and of Auguste Mariette, in Egypt; to say nothing of the labors of antiquarian geologists who have antedated man's existence some thousands of years by the discovery of human remains and works of art coeval with older geologic periods.

It is much to be hoped that the enthusiasm for archæological investigation, so prevalent among European scholars, may develop in this country a corresponding emulation which will throw light upon the mysterious monuments of an antiquity peculiarly our own. It seems hardly credible that a nation like ours, occupying a front rank in all that marks a refined culture, should so long remain indifferent to those evidences in our midst—yearly impaired by time and the hand of improvement—of ancient empires, possibly older than those of the so called old world.

These were not the rude empires of savage and uncultivated races. The complicated system of remains traceable from the great lakes through the verdant valleys of the Mississippi and the Ohio, through Mexico and Central America, and southward along the western slopes of the Andes through Peru into Chili, indicate a powerful, cultivated and peaceful race, and a well organized government. Whence they came, whither they went, or who they were, are questions which deserve our careful consideration, aided by a comprehensive and thorough examination of the memorials which they left.

Doubtless every reader of the Journal is familiar with the general characteristics of the works scattered over the Middle and Southern States, many of which are still traceable even where the plow has been for years engaged in the work of obliteration. They are not merely the slight elevations which mark the temporary lodgment of nomadic tribes, nor the simple burial mound which all nations have at some time erected in memory of their dead. We here behold a system of works projected upon a grand scale, and distinguished by such features of magnitude, engineering skill, astronomical and geometrical knowledge, as stamp the builders a race far superior in culture to the later Indians. While the greater number of these were evidently constructed for peaceful purposes, connected probably with the religious system of the builders, many others are defensive military structures, exhibiting the same marked features of magnitude and skill.

To the latter class belongs Fort Ancient, a brief description of which appeared in a previous number of the Journal. This fortification is one of the largest, and in many respects the most interesting of its kind in the United States; and, singularly enough, no satisfactory account of it appears in any of the published works upon our antiquities, excepting a brief description and survey made by Professor Locke many years ago, and quoted by subsequent writers. Our present object is to describe some of its features—the result of a few days' personal examination—which have escaped observation hitherto. To exhibit these intelligibly it is necessary to recall the general features of the work as described by Professor Locke.

As observed by him, Fort Ancient occupies a spur or promontory of the general plateau projecting into the valley of the Little Miami, elevated two hundred and thirty feet above its waters. The walls of circumvallation, over five miles in extent, and inclosing an area of more than seventy acres, compose, properly speaking, two forts, connected by two nearly parallel lines of embankment, skirting a narrow ridge, and forming a passage which is defended by two large mounds and a cross wall.

The position, naturally one of great strength in a military point of view, is improved to the best possible advantage by lines of entrenchment, so placed as to enfilade all the more accessible points of ingress. Vast quantities of river-worn limestones, laid with some degree of regularity into a wall, form the skeleton of the embankment, over which the earth is massed to a height varying at the present day from five to twenty-five feet. From a rude outline resemblance to the continent of North and South America, some fanciful observers have expressed the opinion that such resemblance was contemplated by the builders; but, in the absence of any reasonable foundation for such belief, we may safely adopt the more obvious conclusion that the outline of the work was made to conform to the topography of the hill which it crowns, so as to form the strongest defense.

Upon first entering this stupendous fortification, one is irresistibly impressed with its vast antiquity. The rounded sectional outline of the wall, and the debris extending its base where the rains of ages have deposited the loose earth washed from the slopes; the numerous breaks caused by the overflow of surface water; and the deep gorges, evidently formed since the construction and abandonment of the work, which drain the interior, all indicate a condition requiring centuries to produce. The native forest within a few years densely covered the entire fort within and without. Giant beeches, oaks, and other trees of slow development, stand indiscriminately within the inclosure and upon the walls, and at their feet lie the prostrate trunks of others fully as large, in all stages of decay; and scattered everywhere around them are the little hillocks and depressions which mark the spot where trees still more ancient grew and fell.

[Judge FORCE, in his interesting pamphlet on the Mound Builders, notes, upon the authority of Judge DUNLEVY, of Lebanon, an entire absence of such hillocks; whence he concludes, the present forest is in the vigor of its first growth, and argues the comparatively recent abandonment of the work—say, a thousand years ago. I ventured to question the correctness of this statement when it appeared, as contrary to my own recollection of observations made years ago. From a recent and careful examination of the ground, with this point in mind, I am able to state, both upon my own investigation and the testimony of old residents who have been familiar with the locality from boyhood, that such hillocks are now and have always been observed within the fort and upon the walls, just as they exist in the oldest forests of the country; and, further, that the growth and general appearance of the forest upon the fortified terrace is identical with that of the surrounding country. The presence of poplar trees, which has been thought by some to indicate a more recent growth, is a feature not confined to Fort Ancient, but common to that side of the river, and extends over a large area.]

The variation in the height of the wall, before remarked, was evidently designed. Wherever the inclination of the exterior slope renders the work more accessible, the wall is higher and stronger, and is correspondingly less so where a precipitous declivity renders a strong defense unnecessary. Thus, where it crosses the neck of the fortified terrace at its junction with the main plateau, a point easily assailable, it is more elevated than elsewhere. At this point, also, the ditch is exterior to the work and still exhibits a depression of three or four feet, twenty feet wide.

Another artificial ditch, the object of which is not apparent, extends from a point about one hundred feet in front of the wall at this part, in a direction parallel to it for three or four hundred feet, until merged in the great ravine separating the fortified terrace from the main land on the southeast. At other points there is a ditch upon the inside, caused, apparently, by excavating earth for the wall, the precipitous sides of the terrace forming an ample protection against assault.

These excavations are frequently so considerable as to suggest a special design in their construction. The utility of such reservoirs is so obvious we may easily suppose they were contemplated by the builders for storing water to the use of those within the work. To these, however, must be attributed many of the so-called "gateways," where the overflow of water has washed away portions of the wall, and formed deep gorges, extending far into the interior and draining it into the larger ravines outside.

The terrace inclosed by the main portion of the work, adjacent to the general plateau, is now cleared and under cultivation; so that upon entering the fort upon the Chillicothe road, from the west, an imposing parapet, nearly twenty-five feet in height, and forming part of the eastern wall, stands in plain view, about a quarter of a mile distant, boldly outlined against the sky. A few large trees, survivors of the original forest, tower aloft, like huge sentinels, standing upon the summit of the embankment, and form conspicuous objects to the view from points several miles eastward.

The wall is here, as elsewhere, pierced by numerous openings or breaks of half its depth, one or two hundred feet apart. Through one of these, which probably formed the main eastern entrance, the Chillicothe road emerges from the fort and passes between two circular mounds situated just without. A shaft, sunk twelve feet to the bottom of one of these, showed the mound to consist of a homogeneous loam, much compacted, and exhibiting the mottled appearance caused by heaping together earth from different localities. The only remains discovered were minute fragments of charred wood distributed through the mound, and, near the surface, a few bones of an ox, somewhat decayed, but evidently an intrusive burial, probably by the later Indians who occupied the fortification.

Two other mounds, now almost obliterated by cultivation, stand within this portion of the work. An examination of these showed them to be places were long-continued fires were had, but for what purpose was not evident, as no remains of pottery or other manufactures were discovered in the vicinity. The earth was burned to a considerable depth, and covered by the debris of burned rock in great quantities.

From the two exterior mounds above mentioned formerly extended two low parallel walls of earth, about fifty or sixty feet apart, nearly half a mile eastwardly to another mound, around which the walls met, forming an enlarged circle. These walls, which have now entirely disappeared, except where division fences cross and protect them from the plow, bordered a roadway leading to the mound.

The care and labor expended in constructing a roadway so marked, suggest certain reflections which are not devoid of interest in this connection. First, it is to be observed that the mound is situated one or two degrees north of east from the main gateway above mentioned, the roadway pursuing a straight line between these points. A similar variation from the true points of the compass exists, it is believed, in some of the similar works in the Scioto and Miami valleys, and also in Florida and Mexico, where there would appear to have been an intention to locate walls, avenues, or elevated teocalli, upon east and west lines. What means the builders had for determining the points of the compass, we are ignorant; but from the manifest skill displayed in other features of construction, we may suppose that in this they possessed some fixed and uniform method of determination. The design apparent in locating works of this kind, especially pyramids and terraces, was to obtain an unobstructed view of the sun in his rising and setting, and may be traced even in the two pyramids of Teotihuacan, traditionally sacred to the sun and moon, situated eight leagues from the city of Mexico, northeast of Lake Tezcuco, which, in the opinion of Baron Humboldt, are the most ancient of all the Mexican structures, and which served the Aztecs as models in the construction of the pyramid of Cholula. It would be difficult to account for this variation, if upon investigation it should be found uniform, unless connected in some way with the obliquity of the ecliptic to the earth's axis of rotation; yet, if such connection could be established, it might furnish a clue to the age of the works, in view of the measurable tendency of the ecliptic, in the course of ages, to coincide with the plane of the equator. The present angle at which the earth's axis is inclined to the plane of the ecliptic is 23° 28′, and becomes less by forty-eight seconds in a century; which would require, in round numbers, nearly eight thousand years to account for a variation of one degree. If we are willing to believe with Alfred Russell Wallace, that the safe side of opinion, as to the antiquity of the human race, is with the large figures, and that "half a million years have probably elapsed since flints of human workmanship were buried in the lowest deposits of Kent's cavern ("Torquay"), we need not be staggered by the results to which such a theory would lead us. Possible changes in the position of the earth's equator might account for this variation, although Sir Charles Lyell has advanced strong arguments against supposing such change to be taking place. Whatever be the result, the point is one deserving of investigation.

Next, the uses to which the mound and roadway at Fort Ancient were devoted, of course, rest largely in conjecture; but it seems not improbable, from various similar features in other works, that upon this mound were conducted the religious ceremonies peculiar to the worship of the sun. Among many other similar works, in various localities, one at Mount Royal, on Lake George, East Florida, corresponds closely with this. As described by Bartram: "A noble Indian highway led from the great mount on a straight line three quarters of a mile, first through a point of the orange grove, and thence through an awful forest of live oaks, terminated by palms and laurel magnolias on the verge of an oblong, artificial lake, on the edge of an extensive green, level savannah. This grand highway was about fifty yards wide, sunk a little below the common level and the earth thrown up on each side, making a bank about two feet high." Parallels leading out to a place of sacrifice, or to a temple, are often met with in ancient Mexican remains. They were found also at Portsmouth, in this State, and elsewhere, as described by Squier and Davis. Bartram also mentions other instances in Georgia.

Acting upon this general belief as to the uses of the mound and parallels, an examination was made of the space formerly bounded by the walls, which was rewarded by the discovery of a well laid pavement of flat river-worn stones, eighteen inches to three feet beneath the present surface, whose width could not be determined by the limited means at command, but it was traced for some distance in its length, and no doubt extends over the entire space between the fort and the sacrificial mound. Coming here upon the palpable evidence of the former use and connection of the mounds and roadway, the imagination was not slow to conjure up the scene which was doubtless once familiar to the dwellers of Fort Ancient. A train of worshipers, led by priests clad in their sacred robes, and bearing aloft the holy utensils, pass in the early morning, ere yet the mists have risen from the valley below, along the gently swelling ridge, on which the ancient roadway lies; they near the mound, and a solemn stillness succeeds their chanting songs; the priests ascend the hill of sacrifice and prepare the sacred fire; now, the first beams of the rising sun shoot up athwart the ruddy sky, gilding the topmost boughs of the trees; the holy flame is kindled—a curling wreath of smoke arises to greet the coming god; the tremulous hush which was upon all nature breaks into vocal joy, and songs of gladness burst from the throats of the waiting multitude as the glorious luminary arises in majesty and beams upon his adoring people—a promise of renewed life and happiness. Vain promise! since even his rays can not penetrate the utter darkness which for ages has settled over this people.

In the immediate vicinity, outside of the main eastern gateway, incredible quantities of flint chips, consisting of fragments of arrow heads, knives, needles, awls, etc., may be gathered from the newly-plowed ground after a shower. These are found in the space of an acre, and exhibit most beautiful specimens of chalcedony, quartz, and other siliceous rocks of various colors. Some of these fragments, found in a half hour's search, rival the finest specimens of the Colorado moss-agate.

Passing thence along the embankment, which forms an elevated path, with occasional detours to avoid the ravines washed out from the interior, the observer, by following the devious windings of the wall, can not but notice the manifest skill by which, as before remarked, the radiating spurs of the natural terrace, which would render assault more easy, are guarded. At the southern extremity of the larger fort the connecting passage, leading into the smaller work, is guarded by a cross embankment or wall, with a central opening protected by the doubling of the wall in the manner of the Tlascalan defenses of Mexico. At the southern extremity of the connecting way stand the two mounds before described, compelling passage between them through a narrow space, easily guarded. The space inclosed by the small fort, crowning the high bluff, around whose base the river winds, has recently been cleared and put under cultivation. The portion nearest the river is the site of a comparatively modern Indian village. The evidences of such occupation are circular ridges, thirty or forty feet in diameter, formed by excavating the earth in a circle to the depth of a foot and heaping it around the circumference. Catlin, it will be remembered, described the Mandan villages of the upper Missouri as built in this manner; the elevation thus formed serving as the foundation of their lodges—a mode of building which he seemed to consider peculiar to that tribe, who, he says, migrated from the Ohio valley in ancient times, "bringing with them some of the customs of the civilized people who erected the ancient fortifications." The comparatively fresh and recent appearance of these remains forms a perceptible contrast to the ancient appearance of the general fortification, which, in connection with other circumstances to be mentioned, shows satisfactorily that this occupation was subsequent to the construction of the work itself.

These lodge marks are thirty or forty in number, disposed in nearly regular order. On the north they extend toward, and in one or two instances overlap, two nearly rectangular spaces, containing perhaps each an acre, readily distinguishable after a rain, by the exceedingly black and rich appearance of the soil as contrasted with the surrounding surface. An examination into the cause of the superabundance of vegetable mold in these places revealed a vast quantity of human and animal bones, fragments of pottery, arrow heads, and other flint implements, stone implements, and a few of bone, all confusedly broken and turned up by the plow and intermingled with incredible numbers of enormous flat limestones.

Excavation, necessarily limited, as the ground was under present cultivation, disclosed only limestones accompanied by similar fragments. The specimens of pottery ware found here in a few hours' search were none larger than the hand, yet represented no less than sixty-five different vessels, composed of dark clay, well burned and tempered with pulverized muscle shells, siliceous and micaceous sand. They were evidently urn-shaped vessels, deposited with the dead in this spot, and, from the uniform blackened appearance of their interior, suggested the presence of fire within, as a means of hardening the clay. Some of these fragments contain exterior designs of geometric figures, skillfully wrought, graven in the plastic clay by a blunt point or pressed by an annular instrument, like a reed or cane. The body of the vessels presented a similar appearance to those described as made within wicker moulds and retaining the imprint of the matrix—a style of ornamentation in these vessels produced by numerous parallel lines crossing each other obliquely, in sets, graven by a toothed instrument, like a comb.

These burials, from the fact that the Indian village had been located over them and apparently without reference to their existence, and also from the generally ancient appearance of the remains, were thought to indicate an earlier date than the occupation by the Indians. That there is no very great difference in these dates, however, is evident by a comparison of the bones thrown out by the plow with those of the Indians buried in the vicinity, as will be noticed. Although the conditions of the latter burials are more favorable for preservation, the remains are decayed to about the same degree. About the lodge marks of the village itself no remains of any kind were found.

The occupants of the village seem to have buried their dead upon that portion of the fort wall contiguous to their dwellings. The characteristic marks of intrusive burial are apparent in the examination of graves which are numerous upon the embankment in the vicinity. These are rarely more than two or four feet in depth, and contain each a single skeleton, buried with the head toward the east, in a rude stone cist, formed by placing flat stones on edge at the sides of the body and covering with similar stones. Despite the apparently favorable conditions for preservation of the bony structure of a human body thus buried, in the mound-shaped parapet, which readily sheds the water, in some cases the skeletons are found exceedingly decayed, and one such cist was opened in which the body was entirely resolved into earth, except a few bones of the hand. By great care, however, two skulls were recovered entire and preserved for examination. These exhibit unmistakable evidences of belonging to the Indian race. The fact, also, that in no case are any relics found interred with the dead in these graves, also distinguishes them from the burials within the fort.

One other fact, however, bearing upon the question of the comparative age of these minor remains, may be disposed of here. Fragments of pottery, in connection with human and animal bones, identical with those found within the fort, were observed in an original deposit upon the present bank of the Miami, a few rods above the railway station at Fort Ancient, subject to overflow; but, as the freshets, now almost of yearly occurrence, were unknown in our western streams before the destruction of the forests, the fact of overflow, as an element in the consideration, loses much of its importance. The main fact established, is, that these remains are coeval with those found within the fort, and that both were deposited after the river had reached its present bed.

The portion of the fort wall where the Indian burials are most frequent, is that which approaches nearest the river, and is a spot whose extreme beauty in situation and surroundings exhibits the noble respect for the dead which led to its selection as a final resting place for the children of nature. The primeval forest still covers the wall and a portion of the precipitous declivity to the river, an almost sheer descent of two hundred and thirty feet. Projected far out into the valley, the point of observation is one which commands an extensive prospect of wood and field, stretching several miles to the northward, until a sudden turn of the valley shuts off the view. Through this lovely vale the "blue Miami" wends its way, between leaf-fringed banks, ever changing, ever the same under the radiant sky of June to-day, as when they whose moldering remains now attract our wondering gaze, roamed ages ago upon its shores, or, wearied from the chase, sported in its limpid stream.

About half way down the declivity, at this point, the three parallel terraces described by Prof. Locke are still to be observed, now covered with a dense and almost impenetrable undergrowth. The river here suddenly expands into a large oval basin, of such extraordinary depth and regular cincture as to seem an artificial formation. It is said, that when the railroad was under construction around the base of the bluff, the declivity being such as to require a foundation for the road-bed partially built up from the river bottom, the great depth of the basin was a serious obstacle, and a vast amount of material was required to make the railway embankment of the requisite width. This portion of the river has for years been designated by residents in the locality as the "deep-hole," and twenty years ago, after being partially filled by the debris of the railway bed, was over thirty feet deep. It is now nearly twenty feet in depth, with a bottom of soft mud, washed in by freshets. The shores exhibit no such conditions as would create a whirlpool or other excavating agency during high water; and in the apparent absence of any natural cause, we might be justified in assuming that it was excavated by the Builders, in connection with a subterranean communication between the fort and the river, in which case the terraces before mentioned would appear to have been designed as stations for guards, to protect the mouth of such passage from hostile attempts during a siege. An unusually large depression within the fort, nearly opposite to this point, now filled with soft mud, washed into it from the surrounding surfaces, gives some color to this supposition; especially, in connection with a tradition of the existence of some subterranean passage within the fort, founded upon the disappearance and reappearance of game when pursued, which is held by residents who have been accustomed to hunt in the woods of the vicinity.

But, warned by the length of this article, it remains only to speak of one or two exterior features, of which no mention has been made by those who have visited this most interesting monument of antiquity. On the side of the river opposite, the hills rise to the same height with the fortification; half way up the acclivity is a level terrace or road-way, extending for one or two miles in either direction, and, perhaps, much farther, wide enough for two wagons to pass abreast; though now broken in numerous places by the hill-side wash, it was evidently once continuous, and, with little repair, might be used as a wagon-way.

A few rods north of the Chillicothe road, on the same side of the river, upon the summit level of the plateau overlooking the river, are the still traceable remains of a lunette or semi-circular embankment, three feet high and fifty feet in diameter, with other walls less distinct, and a few low mounds, all presenting an exceedingly ancient appearance and covered with the primitive forest.

On the east bank, about a mile above the northern extremity of the fort, upon a high spur extending out to the river, is a mound from which a signal from the work could be transmitted a considerable distance northward. Its probable use for such purpose is indicated by burned rock and other debris of fire upon the summit. No other mounds or similar monuments exist in the vicinity, so far as could be ascertained.

This fortification has been known to the whites for nearly a century, during which time it has never been occupied by any tribes of Indians. According to tradition the Delawares in early days inhabited that portion of the State, and roamed the neighboring country. They uniformly disclaimed all knowledge of the origin or purpose of the works, to whom they were as great a mystery as to the white settlers. They were the occasion of much misapplied labor, however, by reporting a treasure buried in some forgotten spot upon the walls by a party of their own tribe, of whom a blind squaw alone survived. The numerous old excavations in and about the embankment attest the faith of the pale faces in the story, and exhibit a degree of zeal in excavation, which, had it been properly applied, might have enlightened posterity upon the question of the origin of the work itself.

The examination of Fort Ancient, the results of which have been thus briefly presented, lead to the following conclusions: The fortification, though built for defensive purposes, seems, from the absence of war-like implements among the remains observed, never to have been the scene of a hostile contest. It has been suggested, that a people dwelling upon the elevated plateau in rear built the forts as places of refuge from attack. The entire absence of remains upon the plateau, however, negatives this view. It appears more probable that the larger fort was a walled town, from which, in case of necessity, the inhabitants could retreat into the smaller work, where, defended on all sides by the precipitous declivity, they had only to guard the connecting passage between. The Tlascalan gateway and the two mounds in the connecting passage were manifestly constructed to defend against invasion from the larger fort. It is true that the only evidences of such occupation thus far discovered, are in the heaps of debris from long continued fires, in mounds which have been leveled by the plow; but when we consider the long period which has elapsed since the abandonment of the work, and the vigorous and exuberant growth which every year adds to the accumulation of vegetable deposit over the remains of the ancient people, we may reasonably anticipate the discovery of certain evidences of their occupation whenever excavations are made deep enough to reach them. The plow only turns up those lying near the surface and marking a comparatively recent period; and the remains thus far discovered, with few exceptions, may be assigned with certainty to the later Indians who successively occupied the entire area covered by the remains of the ancient builders of these works. Some of the arrow and spear heads found in the fort and upon the adjacent hills exhibit a finer material and finish than is common among implements of the Indian races, and fragments of stone implements, gathered in the ancient burial ground before mentioned, correspond in finish and shape with some of the incomprehensible implements taken from the Scioto mounds. But in general, there are no inferences to be drawn from the few specimens recovered, which exclude the supposition that they were used by the later occupants. A beautiful discoidal stone of red ferruginous quartz, pierced in the center, an axe of green-stone, pierced for a handle, and fragments of flat, rectangular stones, such as are supposed to have been used for various purposes—such as sizing threads, weaving, sinking nets, or as "gorgets" or badges of office—are perhaps the only relics thus far found upon which any supposition of an earlier origin could be based. Yet, the fort itself, hoary with age and imposing in its magnitude, bears internal evidences which exclude the restless Indian from all consideration of its origin; while the remains of the sacrificial mounds and the avenue connecting them, and the elevated roadway upon the river slopes opposite the work, seem to connect the Builders with that remote race whose record is still to be deciphered from the palimpsest of Mexican and Central American archæology.

Fort Ancient belongs unquestionably to the same era as the works of the Scioto valley and others of great antiquity. Its place in the general system of defenses extending through Ohio, has been noticed by Judge Force in the pamphlet to which allusion has been made. It is manifest that it is not the erection of a single tribe, for an independent defense, but is a link in the chain drawn across the path of an invading and successful enemy, and as other links had been broken, this, though intact, was abandoned as untenable.

There can be little doubt but that the ancestors of the present Indians were the invaders who drove the peaceful and more civilized Mound Builders from their seats and exterminated their race and name. Ages may have elapsed before their final extinction was complete, and those Indians existing within the historic period may have thus lost—as it appears they had—all trace of the builders of these monuments.

In the protracted contest between the savage hordes of Asia and the Mound Builders we might naturally expect to find—in those tribes which were in the van of the invading host, and therefore longest in contact with the more cultivated native races—a higher civilization than would be acquired by tribes in rear. Such, indeed, we find to be the fact, according to Bartram, Du Pratz, and other early travelers, who witnessed among the Creeks, Cherokees, Natchez, and other southern tribes, many features of superiority to their brethren of the north in the arts and amenities of civilized life. Yet, although they had imbibed something of the peculiar civilization of the Mound Builders, it came to them at so remote a period that they had lost all tradition of the earlier race, even while they acknowledged to Europeans that these works were constructed by a people far more ancient than themselves. Such is the distinct testimony of Bartram concerning the Creeks or Muscogulges, the most civilized of all the Indian nations, and the Natchez, whose customs more nearly resembled the ancient Mexicans.

In this view, supposing the first invaders from the shores of Asia to have been turned southward by the topographical features of the western coast of America, and to have penetrated Mexico and Central America even before the natives of the Mississippi and Ohio valleys were disturbed, we would look to those countries, which were probably the fountain-head of the Mound Builders' civilization, for those greater modifications of the Indian character which they presented at the period of the Spanish conquest. And while the period of occupation by these northern tribes had been sufficiently great to impress their physical characteristics upon the entire people of both North and South America, and to absorb or exterminate whatever of a distinctive earlier type existed, the savage intellect was not able to grasp fully the refined and complicated system which they conquered. Engrafting upon a nobler stock their barbarous ideas, they possessed, at the conquest by Europeans, the hybrid civilization which has been characterized as the most singular spectacle the world ever witnessed—a system whose anomalous and inconsistent features can not be reconciled upon any theory of indigenous growth. Any view of the subject, based upon speculative or theoretical grounds, must be held open to modification by the results of actual investigation. Yet, this would seem to be a fair deduction from all the facts known, and reconciles many apparently conflicting inferences drawn from relics found in and about the works themselves.

Whether this earlier race were identical with those whose remains, closely resembling the singular Central-American bas reliefs, were found in the catacombs of the arid salt desert of Atacama, and pronounced by Dr. Morton to be a race differing in important physical characteristics from all known types of human beings, we perhaps shall never know with certainty. But there is every reason to hope that when the field shall have been more thoroughly gleaned, and the remains more intelligently classified, and when the gloomy coverts of Central American forests shall have yielded up all their treasures; and, especially, when the hieroglyphics shall have received the careful study of scholars familiar with Egyptian and other ancient modes of thought and expression, instead of neglect and indifference, that the history of the ancient dwellers of Ohio will be told as a component part of the great civilized race, whose primal seat was in tropical America, or, possibly, in the lost Atlantis of Plato.

Until these explorations can be made, a labor which seems to be the peculiar province of antiquarian societies or of government, we must be content to regard the problem still unsolved and wander yet longer in the mazes of conjecture, seeking the clue which will lead us to a knowledge of the true ethnic relations and history of the Mound Builders, whose struggle against the tide of invasion, which finally overwhelmed and exterminated them, is attended by silent though eloquent witnesses, like Fort Ancient and other similar works.

Monograph of the Gasteropoda of the Cincinnati Group.

This class of *Mollusca* takes its name from the broad, muscular, disk-like foot attached to the ventral surface, upon which the animal creeps slowly along, with a gliding motion. This movement is produced by the successive expansion and contraction of the foot, which is well shown by the common snail when climbing a pane of glass. The shell, with which the animals are furnished, as in other *Mollusca*, is secreted by the edge of the mantle, and usually forms a conical, spirally twisted tube. The right side of the *Gasteropoda* is usually the largest, which directs the convolutions of the spire in that direction. Such shells are called *dextral.* All fossil shells of this class, yet found in the Cincinnati Group, have their convolutions or whorls turned in this direction, and are hence *dextral* shells. In a few species of existing shells, and in some monstrosities of dextral species, the spire turns in the opposite direction ; these are called *sinistral* shells. Occasionally a *sinistral* shell is found among the *dextral* species of common snails ; it is, however, quite rare.

In the spiral shells, the progressive winding of the tube produces a more or less distinct central axis, called the *columella,* which runs from the apex to the base of the shell, where it forms the inner margin of the aperture, from which the animal protrudes when in motion. The *columella* is usually hollow, and terminates at the base of the shell with a small opening, called the *umbilicus.* The last whorl of the shell is called the *body whorl,* from its receiving the body of the animal when retracted. The remaining whorls form the *spire;* and the impressed line which separates the whorls is the *suture.* The margins of the aperture are called the lips ; the outer lip *(labrum)* forms the convexity of the shell ; the inner lip *(labium)* is usually formed by the columella, and is hence denominated the *columellar* lip. The two lips are sometimes continuous and sometimes separated by a notch, which is often, in the siphonated species, produced into a canal. The shells of the genus *Fusispira* have the aperture prolonged at the base into an extended canal, while the lips of *Cyclora* are continuous. The junction of the outer lip with the preceding whorl is frequently marked with a notch, for the reception of the excurrent siphon, and the outer lip, at the greatest convexity of the body whorl, is frequently marked with a slit, as in *Pleurotomaria* and *Murchisonia.* The margin of the aperture is sometimes termed the *peristome,* and when the aperture is formed in part by the *columella,* such part is sometimes called the *wall of the aperture.* Prof. McCoy characterizes this class as follows :

"Nearly all the *Gasteropoda* enjoy powers of locomotion, and receive their name from the gastric surface of the body being flattened into a disk-like foot, for creeping ; they inhabit salt or fresh water, or the land ; they are all provided with a distinct head, usually furnished with two tentacles, and perfectly formed eyes ; the mouth is provided with contractile lips, and two or three horny jaws ; frequently the tongue is strap-shaped and set with sharp, hooked points, serving either to rasp seaweed food for the phytiverous groups, or capable of boring holes through shells, to reach the food of the carniverous genera ; the mouth opens into a long, winding œsophagus, receiving at the sides the ducts of large salivary glands ; this ends in a large oval stomach ; from which an intestine extends, winding through the great liver and ovary, passing through the bronchial cavity along the base of the gills, terminating at the branchial opening, usually on the right side of the head. In some genera the stomach is armed with calcareous spines, or, as in *Bulla*, with three large grinding plates, concave outwardly. The liver is extremely large and lobulated; the ovaries are large, granulated masses, enveloping the intestine opening into a large oviduct (which is also the uterus of the ovoviperous species), running parallel to the inner edge of the rectum, separated from it by a slender renal duct, and all opening at the same point; the testis forms a more compact gland farther back (in the apex of univalve shells), sending its *vas deferens* close along the oviduct. The heart is systematic, and has one auricle (or in *Haliotis, chiton* and *Fissurella* two) receiving the oxygenated blood from the gills, which, flowing into the ventricle, is thence distributed to the body through an aorta extending from its apex. The eyes never exceed two in number, but are perfectly formed, having a transparent cornea, a large, spherical, crystalline lens, with a small intervening space for the aqueous humor, and a circular pupillary opening left by the choroid or pigmental layer. The organ of hearing consists of two round vesicles, adhering to the anterior œsophagal ganglia, and containing numerous calcareous, oscillating otolites. The shell varies greatly in form and position, according to the group, but is formed in all from the calcification of shells formed in layers under the epidermis, by the edge of the mantel, and irregularities in form of its edge, produce corresponding spines, tubercles, etc., on the shell, which the animal is able to absorb again when they become internal by the spiral growth of the whorls. There are usually three distinct layers in the univalve shells. All the orders are hermaphrodite, except the *Pectinibranchiata*, in which the sexes are distinct. The *nervous system* is greatly more centralized than in *Lamellibranchiata*, and the principal ganglia approximated to the head, there being usually a great pair of supra œsophagal ganglia, or brains, supply the eyes, tentacles, etc., and a great subœsophagal mass of ganglia giving off nerves to supply the foot, the gills, the viscera, etc., connected by cords forming a nervous collar."

The *Gasteropoda* are divided into two sub classes, the *Heteropoda* or *Nucleobranchiata*, which includes only a single order, and the *Gasteropoda* proper.

The *Gasteropoda* form two natural groups; one breathing air (*pulmonifera*), the other water (*branchifera*). None of the *pulmonifera* belong to the Cincinnati Group. The *branchifera* are always provided with a shell whilst in the egg, sufficient to conceal them entirely when first hatched, with a closed operculum. Instead of creeping while young, they swim with a pair of ciliated fins springing from the sides of the head. Their development may be profitably studied in the *Melania* and *Paludina* of the Ohio river.

Cuvier divided the branchifera into the following orders: 1. *Pectinibranchiata;* 2. *Scutibranchiata;* 3. *Cyclobranchiata;* 4. *Tubulibranchiata;* 5. *Tectibranchiata;* 6. *Inferobranchiata;* 7. *Nudibranchiata.* Later authors have united the first four of the above orders into one order. calling it the *Prosobranchiata,* and the last three into another order, calling it the *Opisthobranchiata.* The *Opisthobranchiata* are all hermaphrodites, and very few of them are inclosed in shells; they are not known in the Cincinnati Group.

The *Gasteropoda* of the Cincinnati Group, therefore, belong to the *Nucleobranchiata* and the *Prosobranchiata.*

The *Nucleobranchiata* (Blainville) are so called because the respiratory and digestive organs form a nucleus on the posterior part of the back. They are all inhabitants of the ocean, where they swim about rapidly, instead of creeping on the bed. This order is divided into two families: 1. *Atlantidæ;* 2. *Firolidæ,* and some authors include a third small family, *Sagittidæ.* The *Atlantidæ* have a discoidal shell, large enough to contain the whole animal when contracted; and the gills are contained in a regular branchial cavity. Sometimes they possess a delicate operculum. This family has been subdivided into various families, as *Bellerophontidæ,* etc. It includes the following genera of this monograph, viz.: *Bellerophon, Bucania, Cyrtolites, Microceras.* The *Firolidæ* are either entirely naked, or furnished with a small, conical keeled shell, which incloses the intestinal nucleus, and which very much resembles the *Carinaropsis,* the latter genus may not, however, belong to this family.

The *Prosobranchiata* (M. Edwards) have a spiral shell, into which they can retract themselves at pleasure; the mantle forms an arched chamber over the back of the head, in which the branchiæ are situated, together with the orifices of the alimentary and generative organs. The *branchiæ* are pectinated or plume-like, and situated in advance of the heart. The sexes are distinct and nearly all the species are marine. This order is divided into more than twenty families, and these again are divided into sub-families. The family *Haliotidæ* is characterized as follows:

Shell varying in form from elongate conic to depressed and ear-shaped; aperture wide, indented by the last whorl; nacreous, and with one exception, having either a deep slit or row of foramina in the thin, simple, outer lip, leaving a band which extends back along the whorls of the spire; animal usually too large for the shell; foot wide, oval; operculum rudimentary, or none; eyes on long pedicles at the base of the tentacles; mantle notched or perforated opposite the corresponding apertures in the edge of the shell, to admit the water to the respiratory cavity when the animal is contracted; pectinated nearly equal.

This family, among other genera, includes *Murchisonia, Pleurotomaria, Raphistomia.*

Genus *Bellerophon*—(MONFORT).

[*Etym.*—A fanciful appellation from Bellerophon, a fabulous hero of Greece.]

Shell symmetrical, involute, globose, or discoidally coiled, few whorled; whorls often sculptured; sometimes dorsally keeled; aperture sinuated and deeply notched on the dorsal side.

Bellerophon bilobatus—(SOWERBY, 1839).

Involute, subglobose, height and width about equal; aperture bilobate, large, subreniform; surface marked by fine striæ, which, ascending from the umbilicus, form a broad arch on the side of the shell, and, bending downward, meet in an abrupt curve on the dorsal line.

It is exceedingly rare that the shell of this species is found in the Cincinnati Group, but the casts are found at all elevations from low water-mark to the Upper Silurian formation. The casts, too, are generally very unsatisfactory, and it can not be said they are particularly abundant at any elevation.

Bellerophon Mohri—(S. A. MILLER).

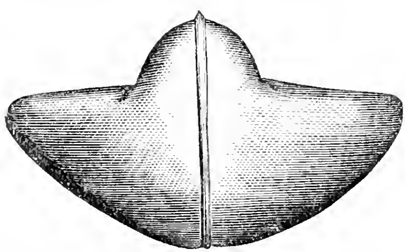

Fig. 30. *Bellerophon Mohri.*—This figure is unsatisfactory, because not sufficiently angulated, and appearing too much compressed.

Shell involute; outer volution abruptly expanded at the aperture, both in length and breadth; inner volutions comparatively small; dorsum angulated and strongly keeled; outer lip, rapidly expanding in a rounded outline upon each side of a shallow sinus, curving abruptly at the point of greatest expansion, and, with the inner lip, forming a line nearly at right angles with the plane of the volutions; inner lip thickened and bearing a prominent node in the middle; surface nearly smooth in the specimens examined, but faint traces of fine lines may be observed, curving with the shape of the shell downward from the sinus, at the outer edge of the expanded aperture.

Aperture two inches in breadth, while the body whorl, just at the commencement of the expansion, is only one half inch across it in the same direction.

This species is remarkable for the strongly carinated dorsum, and for the great expansion of the aperture in proportion to the size of the inner whorls composing the body of the shell.

The specific name is given in honor of Paul Mohr, Sr., of Cincinnati, an experienced and extensive collector of fossils and minerals, and member of the Cincinnati Society of Natural History.

I found the species at Richmond, Indiana, in the upper part of the Cincinnati Group, associated with *Cypricardites Hainesi.*

Genus *Bucania*—(Hall, 1847).

[*Etym.*—*Bukane*, a trumpet; from the form of the shell.]

Convolute; spire equally concave on either side; volutions in the same plane, all visible, outer one ventricose, inner ones usually angulated on the edge, concave on the ventral side; aperture rounded-oval, somewhat compressed on the inner side by contact with the next volution, laterally and dorsally abruptly expanded.

It differs from *Bellerophon*, in having all the volutions visible, and gradually increasing in size.

Bucania expansa—(Hall, 1847).

Convolute, trumpet shaped; volutions three, subangular, the last one elongated, rapidly enlarging and abruptly expanded at the aperture; aperture broadly semi-circular, or sublunate, with a sinus at the dorsal side; dorsal line obtusely carinated; section of the last volution, below the aperture, subtriangular; of the inner volutions, subelliptical, with the extremities obtusely angular; original surface striated.

Found at Richmond, Indiana, near the upper part of the Cincinnati Group. Confined, probably, to a range within fifty feet of the Upper Silurian formation. Casts only are found.

Bucania costatus—(JAMES, 1872).

Shell thin, composed of two and a half to three rapidly enlarging, rounded volutions, the inner of which are contiguous, or possibly very slightly embracing, while the last half turn becomes a little disconconnected from the others; umbilicus rather large and deep; dorsum rounded, and without any traces of a keel; aperture nearly circular, slightly sinuous on the dorsal margin. Surface ornamented by distinct, raised, revolving lines, or costæ, which increase in number by the intercalation of smaller ones between the others, as the shell increased in size, so as to present an alternately larger and smaller series, or, at some stages of growth, showing three smaller between each two of the largest, in which case the middle one of the smaller three is usually a little larger than the other two; crossing the whole, thin, raised laminæ of growth generally occur, at irregular distances, and between these, numerous minute, crowded, transverse striæ may be seen, by the aid of a magnifier.

Greatest diameter, about 0.84 inch; convexity of the body volution, about 0.54 inch.

Mr. James placed this species in the genus *Cyrtolites*, and Professor Meek followed *Cyrtolites*, with the interrogation point of ignorance, and while I am not sure that they are not both right, I, nevertheless, believe it belongs to the genus *Bucania*, in which I have placed it.

I found one specimen on the top of the hill back of Cincinnati, at an elevation of about 400 feet above low water-mark; other specimens have been found in the vicinity of Morrow, in Warren county, at a little greater elevation. It is considered a very rare species.

Genus *Cyrtolites*—(CONRAD, 1838).

[*Etym.*—*Kurtos*, curved; *lithos*, stone.]

Shell thin, symmetrical, horn-shaped or discoidal, with whorls more or less separate, keeled and sculptured.

Cyrtolites ornatus—(CONRAD, 1838).

Convolute; spire equally depressed on either side; volutions, two or three (rarely more than two visible), rapidly enlarging toward the aperture; shell sharply and strongly carinated upon the back, and obtusely angulated upon the sides; ventral side obtusely angulated, with a narrow, deep groove on the summit, for the reception of the dorsal carina; aperture but slightly expanded, quadrangular; section quadrangular; dorsal slopes marked by strong, obliquely transverse ridges, which extend to the angle on the side of the volution; entire surface marked by fine transverse striæ, the spaces between which are crossed by finer curving ones, giving the surface a cancellated appearance.

It is the type of the genus *Cyrtolites*.

The range of this species is co-extensive with the Cincinnati Group, but it usually occurs in the form of mere casts, which do not preserve the surface markings. It is frequently found incrusted with a bryozoum so minute as not to destroy the shape of the oblique transverse ridges, which mark the slopes from the dorsal margin to the angles on the sides of the volution. Well preserved shells are quite rare, though I found good specimens near Versailles, Indiana, about 300 feet below the Upper Silurian rocks.

Cyrtolites Dyeri—(Hall, 1871).

Shell small, laterally compressed, consisting of two or more volutions, the outer one embracing the inner for about half its breadth, bearing a moderately wide umbilicus, in which may be seen a portion of the preceding volution; sides of the volution convex, obtusely subangular near the margin of the umbilicus, into which it curves abruptly and more gradually declines, with a slight convexity toward the salient subcarinate dorsum. Transverse section cordiform, broadest near the umbilical margin.

Surface of the shell marked by from eight to twelve nearly equidistant revolving ridges, with sometimes smaller intermediate ones, and also crossed by numerous closely arranged transverse lamellose ridges, having a double backward flexure between the revolving lines and a general retral direction toward the keel of the shell.

Found in the upper part of the Cincinnati Group, east of Maysville, Ky., at Clarksville, in Clinton county, and near Freeport, Ohio, at about the range of the *Glyptocrinus Nealli*. While its distribution is so general, it is yet a rare fossil, owing probably to its rather small size, and, except when the shell is well preserved, inconspicuous appearance.

Cyrtolites elegans—(S. A. Miller).

Shell convolute, the outer volution on the ventral side receiving, in a narrow groove, the sharp dorsal carina of the inner volution and part of the whorl; about two volutions somewhat compressed and rapidly enlarging; sharply carinated on the dorsal margin; greatest convexity near the umbilical margin; transverse section somewhat cordiform; aperture deeply notched on the outer margin.

Surface marked by numerous, transverse, undulating, subimbricating lamellæ, or raised lines, having a slight forward direction from the keel of the shell.

Diameter of a full-sized specimen, $\frac{2}{5}$th inch; greatest convexity, $\frac{1}{8}$th inch.

It is distinguished from *Cyrtolites compressus*, with which it has sometimes been confounded, by being smaller, fewer whorled, having outer whorl embracing more of the inner whorl, and by having undulating lamellæ much closer, not so regular, nor undulations so great,

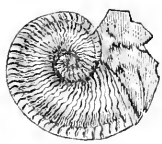

Fig. 31—*Cyrtolites elegans.* Magnified two diameters.

and having a stronger forward direction from the keel of the shell. It is distinguished from *Cyrtolites Dyeri*, which it most resembles, by being destitute of the revolving lines or ridges, and having greater flexure in the forward bearing, transverse lamellæ. Figure 2, plate 13, of the *Paleontology of Ohio*, though a very poor representation of the specimen, I have reason to think belongs to this species. Prof. Meek says of it:

"One specimen, in Mr. Dyer's collection, from the Cincinnati rocks, only shows about five of the revolving ridges on each side, and these are very obscure. Its dorsal keel has a marginal line on each side, and shows the raised marks of growth crossing the very narrow space between these to be distinctly curved backward, like those usually seen on the band of *Pleurotomaria*. In some respects this form resembles *C. compressus*, Conrad, but it differs materially in having the undulating lamellæ of growth *much* more crowded, and in the presence of obscure revolving lines. It seems to me to be only a variety of the above described species (*Cyrtolites Dyeri*)."

The obscure revolving lines, which Prof. Meek thought he discovered, were merely the rows formed by the flexures of the transverse lamellæ and not revolving lines at all. The beautiful cancellated appearance of the *Cyrtolites Dyeri* is wholly wanting in this species.

It has never been found in the range of *Cyrtolites Dyeri*, which is 600 feet or more above low water-mark. Found on the hills within and about the city of Cincinnati, from 400 to 475 feet above low water-mark. It is rare.

The specimen figured is from the collection of C. B. Dyer, Esq., and is a good representation of it.

Cyrtolites carinata—(S. A. Miller).

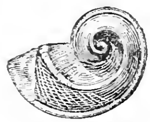

Fig. 32.—*Cyrtolites carinata.* Magnified two diameters.

Convolute; spire equally depressed on either side; volutions two or more, very rapidly enlarging toward the aperture; shell sharply and strongly carinated on the back and sides; dorsal slopes plain between the two carinated edges, with the exception of fine transverse lines which take their rise on the dorsal keel, and arching slightly forward, pass over the lateral carina and down the ventral sides in parallel lines. These lines, even in good specimens, are nearly obliterated on the dorsal sides, but preserve their character quite well on the ventral slopes. Section quadrangular.

This species may be readily distinguished from *Cyrtolites ornatus*, which it most resembles, by the sharp carina on the sides and absence of the "*oblique transverse ridges*," which characterize that species. The fine curving lines, too, are wanting, so that it never presents a cancellated appearance, at least not on any specimen observed. I think, too, that it enlarges more rapidly toward the aperture.

Its range is unknown, but the specimens collected, so far as I have information upon the subject, have been found within two hundred feet of low water-mark, at Bold Face Creek, opposite Fifth street, and at the excavation for Columbia avenue.

Genus *Microceras*—(Hall, 1845).

[*Microceras*—in allusion to its small horn shape.]

Shell small, smooth, convolute; volutions few, horizontal, rapidly diminishing from the aperture; subcarinated upon the back; whorls contiguous, but not involute.

Microceras inornatus—(Hall, 1845).

Shell very small; volutions about two, rapidly increasing in size, slightly embracing, most convex near the umbilicus, and obtusely carinated or angular upon the back; carina more conspicuous near the mouth and gradually becoming obsolete; umbilicus scarcely as wide as the dorso-ventral diameter of the outer volution at the aperture, and rather deep; aperture somewhat quadrangular; surface smooth. Diameter, 0.07 inch; convexity, 0.04 inch.

Prof. Meek suggests that this species should be placed in the genus *Cyrtolites*, for, he says, "I know of no other reasons than their small size, smooth surface, and perhaps their less acutely angular dorsal margin, for separating them from that genus." These reasons seem to me sufficient for retaining the name of Hall's genus, *Microceras*. There is a wide gap between such minute, smooth fossils and the large, sculptured *Cyrtolites*.

It is found in the run at Plainville, on Vine street hill, at Versailles, Indiana, and generally at all elevations throughout the Cincinnati Group. It is not, however, very abundant at any locality. Those found by me, at Versailles, are about four times as large as those found at Plainville.

Genus *Cyclora*—(Hall).

Shell minute, smooth, consisting of few whorls; aperture circular.

Prof. Meek suggests that this genus probably belongs to the family *Rissoidæ*.

Cyclora minuta—(Hall).

Shell small, smooth, wider than high; volutions about three, rounded, increasing rapidly in size, so that the last one forms the larger bulk of the shell; spire depressed; suture deep, almost channeled; aperture circular, lip thin; umbilicus small.

This species has a range, from low water-mark in the Ohio river, to the Upper Silurian rocks, and is dispersed almost throughout the Cincinnati Group. It varies in size in different localities. In some localities it is so minute as to appear a mere speck, without the aid of a glass, but at Versailles, Indiana, I found specimens having a height of about $\frac{5}{60}$th inch; breadth, $\frac{6}{60}$th inch. It is a very common fossil.

Cyclora (?) parvula—(Hall).

Shell small; spire elevated, conical; volutions three, increasing moderately in size to the last whorl, which rapidly enlarges, the upper ones being nearly round, and the lower one angular at the middle; suture very deep, in consequence of the convexity of the whorls; aperture nearly circular, slightly projecting downward, and angular at the outer margin; umbilical perforation very small; surface smooth.

It varies considerably in size; a medium specimen has a length of about $\frac{3}{60}$th inch; breadth about $\frac{2}{60}$th inch.

Found back of Plainville, on Vine street hill, at Versailles, and at other places throughout the Cincinnati Group, associated with *C. minuta*. It is, however, comparatively rare.

Cyclora Hoffmanni—(S. A. Miller).

Fig. 33.—*Cyclora Hoffmanni.* Magnified about ten diameters.

Shell very small; spire elongated, volutions five or six, round, increasing very gradually in size; suture deep, in consequence of the great convexity of the whorls; aperture nearly circular, projecting slightly downward; surface smooth.

Length of a medium sized specimen, $\frac{4}{60}$th inch; width less than $\frac{2}{60}$th inch. The length is nearly three times as great as the width.

It is found in the run back of Plainville, associated with *C. minuta* and *C. parvula*.

The specific name is given in honor of John W. Hoffmann, of Cincinnati, a member of the Society of Natural History, and active collector of fossils. He found the *Anomalocrinus incurvus* (which is figured in the Ohio Paleontology, from my cabinet), and more recently he discovered an *Asaphus (Isotelus) megistos*, about eleven inches in length and seven inches in breadth.

Genus *Carinaropsis*—(Hall, 1847).

[From its resemblance to *Carinaria*.]

Symmetrical, subconical, patelliform, subangulated or carinated on the dorsal line; apex incurved or convolute; aperture oval, narrowed posteriorly.

Carinaropsis patelliformis—(Hall, 1847).

Obliquely subconical, patelliform, the apex incurved and extended in a line with or beyond the margin, obtusely carinated upon the dorsal line; aperture broadly oval, slightly narrowed posteriorly; surface marked by fine concentric sublamelliform striæ.

The fossils referred to this species are quite rare; one, which I have, I found at the quarries back of Cincinnati; Dr. R. M. Byrnes has one that he found about the city, but does not recollect where, and Mr. James has the best one I have seen, which he found several years ago, but does not remember the locality. Its range is therefore unknown.

Genus *Murchisonia*—(D'Archiac).

Shell elongated, many whorled; whorls variously sculptured, and zoned like *Pleurotomaria;* aperture slightly channeled in front; outer lip deeply notched. The appearance is somewhat like an elongated *Pleurotomaria.*

Murchisonia bellicincta—(Hall, 1847).

Elongated; spire composed of eight or more volutions, which are regularly convex, and somewhat rapidly enlarging from the apex; volutions moderately oblique, marked upon the center by a flat spiral band, which is margined by slight sharp elevations; striæ bending backward from the suture to the mesial band, upon which they make an abrupt curve forward; aperture rounded, extending below, with the columellar lip nearly straight.

This is a large and beautiful species, known by its moderately ascending spire and regularly ventricose whorls, which render it readily distinguishable in its usual condition, as casts of the interior. The mesial band divides the volution almost equally, producing no appreciable elevation except at the sharp marginal carina; and where these are worn down, as they sometimes are, the volutions preserve their equal convexity.

It is known in the Cincinnati Group only in the form of casts, but these so nearly resemble the description that no doubt seems to be entertained about the identity of the species. It has a wide range, being nearly coextensive with the group, and is reasonably abundant in many localities. It is a common fossil.

Murchisonia gracilis—(Hall, 1847).

Slender, elongated; volutions not less than ten, ventricose, subangulated on the middle, very gradually increasing in size from the apex toward the aperture; surface marked by a carinal band upon the center of the volution, with curving striæ above and below. Casts of the shell are entirely free from the angular carina.

This fossil is likewise known only in the form of a cast in this locality, with from six to eight volutions. Its range is very extensive, but it is not remarkably abundant.

Murchisonia bicincta—(Hall, 1847).

Obliquely subconical; spire elevated, acute; volutions four or five, angular, rapidly enlarging toward the aperture; last one ventricose below, tricarinate, the lower carina hidden by the suture of the next volution at the upper inner angle of the aperture; central carina on the outer angle of the volution, margined on either side by a sharp, elevated line, with a narrow groove between, producing a double spiral band; aperture oblong, angulated below; surface marked by fine, sharp striæ, which bend gently backward, and are but slightly undulated in passing the first carina, from whence they turn more suddenly backward to the mesial band, making an abrupt, retral angle, and then bending forward below, pass in a vertical direction to the suture. In the last volution, the striæ pass vertically to the lower slight carina, which corresponds with the suture in the other volutions, and from thence bend slightly backward, curving into the umbilicus.

The specimens referred to this species are usually mere casts; sometimes, however, part of the shell is preserved, but the finer striæ I have never seen. Its range seems to be confined to the lower part of the Cincinnati Group, probably not found over 300 feet above low water-mark.

Genus *Fusispira*—(Hall, 1871).

Shells fusiform, imperforate, spire more or less elevated, with rounded volutions; aperture elongate-ovate, or elliptical, produced below, forming a subrimate canal; columella slightly twisted, without folds; peristome sharp; surface smooth.

The shells have the general form of *Fusus*, and particularly the group *Tritonofusus* of Beck; being smooth shells with subequal extremities, but the columella is much less twisted, which gives to them a more erect aspect. They differ from *Subulites* in not being truncate at the base of the columella, and in being destitute of the deep basal notch characteristic of that genus.

Types, *Fusispira ventricosus* and *F. terebriformis.*

Fusispira terebriformis—(Hall, 1871).

Shell terete, acute (subfusiform) consisting of about six, gradually increasing, depressed convex volutions, the last one of which forms about two fifths of the entire length of the shell, exclusive of the anterior prolongation; aperture narrow, obliquely elliptical, strongly modified above by the preceding volution, and prolonged below, forming an extended canal; surface apparently smooth; apical angle about thirty degrees.

This species is found at the quarries back of Cincinnati, though good specimens are very rare. Its range is not known.

Fusispira subfusiformis—(Hall).

Fusiform, elongated; spire rapidly ascending; volutions about six or more, flattened, lower one large and ventricose; aperture oval, acutely extended below; surface unknown.

All the specimens yet discovered are casts, which preserve no part of the shell or external markings. It is readily distinguished from *F. terebriformis*, by the greater obliquity of the volutions, which are flattened, and never present the regular convex outline of that species.

The specimens referred to this species are quite rare, and have been found in the lower part of the Cincinnati Group.

Genus *Pleurotomaria*—(Defrance).

[*Etym.*—*Pleura*, side, and *tome*, notch.]

Shell, trochiform, solid, few whorled, with the surface variously ornamented; aperture subquadrate, with a deep slit in its outer margin. The part of the slit, which has been progressively filled up, forms a band round the whorls.

Pleurotomaria subconica—(Hall, 1847).

Trochiform; spire elevated, apex acute; volutions about five, flattened above, with a projecting carina just above the suture; last volution strongly carinated on the outer edge, and marked with a spiral band, ventricose below; aperture transverse, subquadrate, angular on the outer side and round below; surface marked by fine striæ, which bend gently backward from the suture, and more abruptly on the lower part of the whorl; spiral band a distinct groove, margined by sharp elevated edges, upon which the striæ bend backward in an abrupt curve; below this the striæ bend gently forward, and thence curving backward, terminate in the umbilicus; longitudinal striæ crossed by transverse, sharp, elevated lines, which are finer than the longitudinal ones.

The casts referred to this species are found in the upper part of the Cincinnati Group, at Weisburg, Richmond, and other places.

Pleurotomaria tropidophera—(Meek).

Shell rather small, obliquely rhombic in general outline, as seen in a side view: height somewhat greater than the breadth; spire conical, with an apical angle of about 70 degrees to 90 degrees; volutions four to four and a half, each flattened, or sometimes slightly concave above, with an outward slope from the suture to a prominent angle, that passes around the middle of the body turn, and below the middle of those of the spire, to which it imparts a somewhat turreted appearance; suture moderately distinct, but not channeled; lower side of body volution sloping rapidly inward from the mesial angle, a little below which there usually revolves an obscure, undefined ridge; aperture rhombic, subquadrate. Surface nearly smooth, but sometimes showing under a magnifier very obscure lines of growth, that curve very strongly backward as they approach the angle around the middle of the body volution, both above and below; thus indicating the presence of a deep sinus in the lip, widening rapidly forward, though there is no defined revolving band at the angle.

Height, 0.55 inch; breadth, 0.50 inch.

I found this species at Versailles, Indiana, about fifty miles west of Cincinnati, and 300 feet below the rocks of the Upper Silurian. It is a rare species.

Pleurotomaria Halli—(S. A. Miller).

Fig. 31—*Pleurotomaria Halli*, magnified two diameters—apex broken off.

Shell rather small, about two whorls, rapidly enlarging toward the aperture; spire short; slightly convex on top and plain below, with the exception of the projecting aperture, and marginal band, giving it in one view a plano-convex appearance; umbilicus closed; edge of the outer volution marked with a sub-cylindrical band, leaving a slight depression on the upper and a marked curved groove on the lower side; aperture rapidly expanded below and notched at the band.

The specimen figured has the shell partly removed from the last whorl, and the upper side so worn as not to show any surface markings. The band at one place shows rovolving lines. The lower side seems to be well preserved, and has no surface markings.

I found this specimen about 340 feet above low-water mark, and do not know of another specimen at this time.

The specific name is given in honor of J. W. Hall, Principal of the Covington schools, curator of palæontology in the Cincinnati Society of Natural History, and famous, too, for his peculiar trait of collecting large quantities of fossil corals, and making the rough places smooth.

Genus *Raphistoma*—(Hall, 1847).

[*Etym.*—Gr. *raphe*, a seam or suture, and *stoma*, mouth; from the suture or seam-like appearance in the upper side of the aperture.]

Shell depressed, turbinate; discoidal spire, with three to five volutions; suture close; umbilicus moderately large; aperture subtrigonal; upper side of the volutions marked by a kind of seam or suture, produced by the sudden tendency backward of the striæ, which leaves a slight notch in the edge of the aperture.

The slight notch in the upper edge of the aperture, which is marked in the progressive growth of the shell, by a simple seam or bending in the striæ, is somewhat similar to the notch and band of *Pleurotomaria;* but the outer angle of the volution presents no band, but a simple bending of the striæ.

Raphistoma lenticularis—(Conrad).

Shell lenticular; breadth generally a little more than twice the height; convexity often nearly equal above and below; volutions about four and a half, flattened or slightly concave, with a moderate slope above, coincident with that of the spire, the outer or last one sharply carinate around the periphery, and convex below, the greatest convexity being near the umbilicus, into which the slope is abrupt; suture merely linear, and not very distinctly defined; umbilicus nearly as wide as the outer volution, as seen in internal casts; aperture transversely rhomboidal, the breadth being about one fourth wider than the height.

The specimens, which may be very doubtfully referred to this species, are found at different elevations throughout the Cincinnati Group. They are usually mere casts. Prof. Hall referred *lenticularis* to the genus *Pleurotomaria*, and if this reference is right, then, I think, that the specimens found here belong to another species. The specimens found here seem to me to have the generic characters of *Raphistoma*, and an examination of specimens having the shell apparently very little worn, discovered none of the striæ marking the surface of this species.

Genus *Cyclonema*—(Hall).

[Gr. κυκλος, *ambitus*, and νεμα, *filum*, in allusion to the elevated thread-like striæ marking the surface of several species.]

Shell turbinate, thin; spire short, consisting of few volutions, which increase rapidly from the apex; aperture large, rounded anteriorly, and somewhat flattened on the columellar side; umbilicus none; surface strongly marked by spiral, thread-like striæ, which are cancellated by finer striæ.

The shell has no slit or indentation in the outer lip, or band upon the volution. The surface is marked by elevated striæ, parallel to the direction of the volutions, and the spaces between these are marked by finer striæ, crossing the others obliquely; the latter, however, are often obsolete.

Cyclonema bilix (Conrad), is the type of the genus.

Cyclonema bilix—(Conrad).

Obliquely conical; spire short, composed of four or more volutions, which are somewhat appressed above and ventricose below; last volution somewhat flattened on the lower side; aperture rounded, or slightly transverse; surface marked by numerous, strong, spiral carinæ, which frequently alternate with finer ones; these are crossed by fine striæ, which, commencing at the top of the volution, pass obliquely backward to the base, or into the umbilicus, suffering no alteration of their direction upon the carinæ.

This is a common form found at the quarries about Cincinnati, and has a range very near or quite cöextensive with the Cincinnati Group. The shells differ very much in general appearance, and vary in size from one fourth of an inch, or less, to more than an inch in height. Prof. Meek characterized them as "varying from rhombic subglobose to conoid-subtrochiform," which is sufficiently lucid without further explanation.

Prof. Meek figured a form in the Ohio Palæontology, for which he proposed the name *C. bilix var. lata*. It is so much depressed as to be decidedly wider than high, and has along with the usual fine, regular, revolving lines, and minute oblique striæ of growth, strong, oblique, rounded ridges, interrupted by a broad, shallow depression around the middle of the upper slope of the body volution. This is the same described by Mr. James, as *C. fluctuata*, on page 152 of the April number of this Journal. Its range commences more than 300 feet above low water-mark, and extends to near the Upper Silurian, being but little less in extent than the *C. bilix*, though it is comparatively quite rare.

I now propose the name *Cyclonema bilix var. conica*, for the form figured as a *Cyclonema bilix*, in the Ohio Paleontology, plate 13, figure 5*g*, and characterize it as follows: shell conical, about one fifth longer than greatest breadth; volutions about five, flattened, usually rather more convex on the lower than upper side; suture very shallow; aperture subquadrate and expanded below; surface marked with revolving lines, crossed by regular, finer, oblique lines, and occasionally irregular, oblique ridges, giving it a beautiful cancellated appearance.

It will be readily observed that this is one of the extreme forms, within the varying characters ascribed by Prof. Meek to this species. But there is this reason at least for giving it the name of a variety: it has never, to my knowledge, been found at Cincinnati, though Prof. Meek had such information, as it seems, respecting the specimen he figured. It is found at an elevation of about 600 feet above low water-mark, thirty or forty miles east, west and north of Cincinnati, and has a more restricted range than Prof. Meek's *var. lata*.

For *C. pyramidata* (James), see page 152, April number of this Journal.

Cyclonema varicosa—(Hall).

Shell turbinate; height and greatest breadth about equal. Spire consisting of about four volutions, which increase rapidly in size, the last one extremely ventricose; the lower side somewhat flattened near the upper part of the columella, which is straight and thickened. Aperture as wide as high, transversely semi-oval.

Surface marked by strong revolving striæ, about three of which on the upper volutions and four or more on the last volution become more strongly developed, and give a subcarinate form to the volutions: between these the striæ are fewer and unequal. The revolving striæ are crossed by finer lines of growth, which on the upper volutions are nearly uniform, but toward the aperture become crowded, unequal, and sublamellose.

This species resembles the *Cyclonema percarinata*, but is more ventricose, with different surface markings. It is larger, more ventricose, and very differently marked from *C. bilix*. It is regarded by some, however, as merely a variety of *C. bilix*. It is found on the hills back of Cincinnati, but is not common.

Cyclonema percarinata—(Hall).

Somewhat obtusely conical, ventricose; spire short, obtuse; volutions three or four, rounded, marked by numerous spiral carinæ, which are crossed by vertical or undulating striæ; aperture not distinctly visible, but apparently it is broadly oval or rounded; umbilicus none.

It is distinguished by the numerous spiral, elevated ridges or carinæ, which mark the surface.

It is found at Cincinnati, from low water-mark to about 250 feet above, though it is not abundant at any known locality.

Notes on the Molluscan Fauna of Northern Illinois.—By W. W. Calkins.

The author hopes to publish at some future time a complete monograph of all the mollusk species of Illinois, giving a figure of each, and embracing in the work such new facts as he may obtain in regard to the distribution of species in the State, their classification, etc. It is probable that nearly all the American terrestrial species have been described. But much work yet remains in the department of aquatic mollusca in rectifying past errors, eliminating synonyms, and fixing the geographical limits of species. The latter has now become the most important matter claiming the attention of the naturalist. We may not presume to see many new species added to the already formidable list, but we shall have the position of those now imperfectly known more fully settled; and we may expect to see several of Thomas Say, which are at present classed among the synonyms, restored to their proper places as species. In regard to the classification and grouping of species, we may consider the present systems as transitional. Some species now treated as subgenera, will, when that ceases to work, be treated as genera. The family Unionidæ will be revised, and new groupings arranged, more in accordance with the common characters among some of the members. The Strepomatidæ will afford a fruitful field of investigation for some time to come. This family presents the most remarkable study in the whole range of American conchology. When we reflect that nearly five hundred species have been described, and about ninety per cent. of these from waters south of the Ohio river, we can form some idea of the varieties in this single group of the mollusca. Not less interesting are Melantho and Vivipara. From them we may hope to establish seven or eight permanent species. Though the process of future study and research will no doubt cut down the number of species, yet enough will remain to demonstrate the extraordinary development of American molluscous life. The following are common to the northern half of the State of Illinois:

Family *Helicidæ.*—Genus *Macrocyclis*—(Beck).

M. concava, Say. This carnivorous species is very abundant and of large size.

Genus *Zonites*—(Montford).

Z. arboreus, Say; *Z. viridulus*, Menke. *Z. fulva*, Drap. *Z. cellaria*, Muller. The latter is an introduced species, and found in great numbers around greenhouses where foreign plants are kept. It is the same no doubt as *H. glaphyra*, Say, *Z. minuscula*, Binney. Not abundant, so far as I have observed. *Z. lineata*, Say; abundant.

Helicinæ.—Genus *Patula*—(Halde).

H. alternata, Say. *H. alternata*—a variety resembling *mordax*. *H. solitaria*, Say, *H. striatella*, Anth. *H. perspectiva*, Say. All the preceding, except the last two, are very abundant.

Mesodon—(Raf).

H. albolabris, Say. *H. multilineata*, Say. *H. pennsylvanica*, Green. *H. exoleta*, Binney. *H. thyroidus*, Say. *H. clausa*, Say. *H. profunda*, Say. *H. diodonta*, Say. The latter has been given me as from Illinois; I have never found it myself. Known as *H. Sayii*, Binney.

Stenotrema—(Raf).

H. hirsuta, Say. *H. monodon*, Rack. *H. monodon*, *var. Leaii*. Ward.

Strobila—(Morse).

H. labyrinthica, Say. Very abundant.

Genus *Pupa*—(Drap).

Pupilla.

P. pentodon, Say. Very abundant.

Leucochila.

P. fallax, Say. *P. armifera*, Say. *P. corticaria*, Say. All abundant.

Genus *Succinea*—(Drap).

S. obliqua, Say. *S. avara*, Say. *S. retusa*, Lea. The latter species is very abundant in the calumet swamps. I believe these are all the species of *Succinea* that can be found in the northern half of the State. But I have known as many as seven species reported from one county. I have not been there. Nor can I credit any such number as existing in a single small district.

Limnophila.

Family *Auriculidæ*.—Genus *Carychium*—(Muller).

C. exiguum, Muller. Very abundant.

Family *Limnæidæ*.—Genus *Limnæa*—(Lam).

L. reflexa, Say. *L. pallida*, Ad. *L. humilis*, Say. *L. desidiosa*, Say. *L. caperata*, Say. *L. palustris*, Muller. *L. stagnalis*, Linn. *L. appressa*, Say. *L. umbrosus*, Say. *L. zebra*, Tryon. *L. catascopium*, Say. All abundant.

Genus *Physa*. (Drap).

P. gyrina, Say. *P. hildrithiana*, Lea. I think the latter may be retained as a distinct species, though considered by some to be the same as the former. Both are abundant.

Genus *Bulinus*—(Ad.)

B. hypnorum, Linn. Abundant.

Genus *Planorbis*—(GUET).

Pla. glabratus, Say. *Pla. campanulatus*, Say. *Pla. trivolvis*, Say. *Pla. cicarinatus*, Say. *Pla. deflectus*, Say. *Pla. parvus*, Say.

Segmentina—(FL.)

S. armigera, Say. Very abundant.

[Genus *Ancylus*—(GEOF).

Anc. tardus, Say. Associated with this species may be found the nest of an insect, *Phrygania*. This nest resembles the *valvata* in shape, and is built of sand and mud cemented together.

Family *Valvatidæ*.—Genus *Valvata*—(MULLER).

The two species, *V. tricarinata*, Say, and *V. sincera*, Say, are found in abundance. These may eventually be united in one species.

Family *Viviparidæ*.—Genus *Vivipara*—(LAM).

V. intertexta, Say. *V. subpurpurea*, Say. *V. contectoides*, W. G. B. The latter very numerous.

Genus *Melantho*—(BOW).

M. subsolidus, Anth. This shell becomes thinner in the northern part of the State and is called *integra*. *M. decisus*, Say. *M. rufus*, Halde. *M. coarctata*, Lea. Forms resembling *obesus* and *exilis* also occur.

Genus *Lioplax*—(TROS.)

L. subcarinata, Say. Abundant.

Family *Rissoidæ*.—Genus *Amnicola*—(G. & H.)

A. porata, Say. *A. cincinnatiensis*, Anth. Both these species are abundant.

Bythinella—(TAND).

B. obtusa, Lea. Very abundant.

Somatogyrus—(GILL).

S. depressus, Tryon. Abundant.

Pomatiopsis—(TRYON).

P. lapidaria, Say. *P. cincinnatiensis*, Lea. Very abundant.

Family *Strepomatidæ*—(HALDE).

Pleurocera—(Raf).

P. subulare, Lea. *P. lewisii*, Lea. Both abundant. The latter will probably prove to be a good species.

Goniobasis—(Lea).

Gon. livescens, Menke. *Gon. depygis*, Say. All other reported species of Goniobasis from this section may be referred to one of the above.

Conchifera.

Family *Cycladidæ*—(W.)

Genus *Sphaerium.*

S. simile, Say. *S. partumeium*, Say. *S. occidentale*, Pr. *S. transversum*, Say.

Genus *Pisidium*—(Pfr.)

P. abditum, Pr. *P. compressum*, Pr.

Family *Unionidæ.*

U. æsopus, Green. *U. alatus*, Say. *U. anodontoides*, Lea. *U. cornutus*, Bar. *U. capax*, Green. *U. coccineus*, Lea. *U. crassidens*, Lea. *U. donaciformis*, Lea. *Do.*, *var. zigzag*. *U. dorfeuillianus*, Lea. *U. elegans*, Lea. *U. ellipsis*, Lea. *U. ebenus*, Lea. *U. gracilus*, Bar. *U. gibbosus*, Bar. *U. iris*, Lea. *U. luteolus*, Lam. *U. lævissimus*, Lea. *U. ligamentinus*, Lam. *U. metanevrus*, Raf. *U. multiplicatus*, Lea. *U. monodontus*, Say. *U. novi-eboraci*, Lea. *U. occidens*, Lea. *U. obliquus*, Lam. *U. orbiculatus*, Hild. *U. pustulosus*, Lea. *U. pustulatus*, Lea. *U. plicatus*, Lesueur. *U. parvus*, Bar. *U. rectus*, Lam. *U. rubiginosus*, Lea. *U. retusus*, Lam. *U. securis*, Lea. *U. spatulatus*, Lea. *U. solidus*, Lea. *U. tuberculatus*, Bar. *U. triangularis*, Bar. *U. trigonus*, Lea. *U. undulatus*, Bar. *U. verrucosus*, Bar.

Margaritana—(Schum).

M. complanata, Bar. *M. confragosa*, Lea. *M. rugosa*, Bar. *M. marginata*, Say. *M. deltoidea*, Lea.

Anodonta—Brug.

A. edentula, Lea. *A. ovata*, Lea. *A. imbecillis*, Say. *A. corpulenta*, Cooper. *A. suborbiculata*, Say. *A. grandis*, Say.

Remarks upon the Genus Anomalodonta and the words Megaptera and Opisthoptera, and the species gigantea and alata. [From the American Journal of Science and Arts, for September, 1874.]

In the first issue of the Cincinnati Journal of Science, I observe that the editor, Mr. S. A. Miller, proposes a new genus under the name of *Anomalodonta*, to include a group of shells allied to *Ambonychia* of Hall. These shells constitute a very interesting type, evidently belonging to the family Aviculidæ. Like *Ambonychia*, they are destitute of an anterior wing, but have, posteriorly, a very large one, which gives the shell a trigonal outline. Mr. Miller's type specimens show them to have a broad striated area, such as *Myalina* possesses, with, at the anterior end of the hinge, an oblique fold or ridge, not properly a tooth perhaps, together with a corresponding depression in one or both valves. We see just such characters in the broad forms of *Myalina*, as for example in *M. ampla* of Meek and Hayden, so that, although generically distinct from Mr. Miller's shell, there seems to be little to distinguish the latter, except outline and radiating costæ, unless he is right in stating that his shell has a large impression of the anterior adductor muscle, which, in view of the affinities of the shell, is very improbable, especially so large an impression and in so low a position as he has figured it. Compared with *Ambonychia*, the hinge of his shell differs materially, in wanting the two anterior well defined teeth of that genus and also its three elongated posterio-lateral teeth.

This genus *Anomalodonta* was proposed for a group of shells identical with the one for which Meek and Worthen proposed the subgeneric name of *Megaptera*, in the Proceedings of the Chicago Academy of Science in 1866. Mr. Miller himself states that his proposed genus will include *Ambonychia* (*Megaptera*) *alata* Meek (Ohio Paleontology, vol. i., p. 131), of which he says Mr. U. P. James has specimens showing the same hinge characters. He also states that his proposed genus will include, among others, *Megaptera Casei* of Meek and Worthen, which is the type species of *Megaptera*. In short, he proposes a new genus to include the type of a previously established one, together with another species of the same, described by one of the authors of the forenamed genus. *Megaptera* has unquestionable priority, and must stand before Mr. Miller's name and all others also; unless, however, the name *Megaptera* may be objected to on account of its previous use by Dr. Gray for a genus of whales. Even in that case Mr. Miller's name could not stand, because Mr. Meek, in the Proceedings of the Philadelphia Acadamy Natural Sciences, 1872, proposed to use the name *Opisthoptera* as a substitute in case such objection should arise. Indeed, I am informed by a friend that Mr. Meek, in his work, now in manuscript, has decided to use the name *Opisthoptera Casei* and *O. alata* for *Megaptera Casei* and *M. alata*.

The fact that Meek and Worthen did not describe the hinge of *Megaptera*, which was unknown to them, in their generic diagnosis, has no bearing upon the question of priority. If it were otherwise, few genera of fossils would be allowed to stand after the discovery of more perfect specimens than the original workers possessed. Nor does the fact that Meek and Worthen called theirs a subgenus affect the question, for the rule covers such cases as well as others, and the use of such a designation under similar circumstances indicates on the part of an author a degree of caution that all true naturalists will approve.

Further, upon comparing Mr. Miller's description of his species *gigantea* with Meek's *alata*, I am unable to find that the former possesses characters sufficient to separate it specifically from the latter. Mr. Miller seems to have relied solely upon the large size and the preservation of concentric striæ of his shell to separate it from *M. alata*. As Mr. Meek distinctly mentions the existence of the striæ in his shell, Mr. Miller's species seems to be reduced to the very insufficient ground of size alone. C. A. W.

I presume, from the initials, that the author of the foregoing criticism is, Prof. C. A. White. In answer to it, I shall, first, call attention to the fact, that the Professor is unable to find, that the species *gigantea* possesses characters sufficient to separate it specifically from the *alata*. This difficulty, which he has encountered, may be owing to the imperfect description, by Prof. Meek, of the *alata*, or to my imperfect description of the *gigantea*. It certainly is the fault of one of us, or his own mistake, for the specific differences are so strongly marked as to leave no doubt upon the subject.

I am inclined to think that it is his mistake, for, however imperfect the descriptions may be, a glance at fig. 9, on page 18, of the January number of this Journal, and fig. 10, plate 12, of the Ohio Paleontology, ought to have suggested some important specific differences, even to a tyro in paleontology. But let us compare the descriptions of the surface markings as published:

1. *Gigantea*.—" Surface marked by 30 to 40 strong radii, same width as intermediate spaces, which are concave grooves, marked with concentric striæ, giving much the same external appearance as those of

an *Ambonychia radiata.* Shell marked, exteriorly, toward the margin, with lines of growth and concentric striæ, which cross the radii, rendering it likely that concentric striæ crossed the radii over the whole surface of the shell, though they appear now to be smooth."

2. *Alata.*—"Surface ornamented by about 24 to 28 simple, strong, radiating costæ to each valve, that are nearly equal in breadth to the furrows between; those on the central portions of the valves passing nearly straight from the beaks obliquely to the posterior basal margins, those on the anterior side curving more or less forward below, and those near the cardinal margin curving a little upward behind; in some examples, crossing all of these costæ and the furrows between, are numerous, fine, crowded lines, and at regular, distant intervals a few strongly defined, imbricating marks of growth, that curve parallel to the basal and posterior margins."

Now, let us see what are the specific differences here manifest to an ordinary paleontologist:

1. The *gigantea* has 30 to 40 strong radii, while the *alata* has 24 to 28. Let it be borne in mind, that the chief specific differences between the three species of *Ambonychia* (*radiata*, *bellistriata*, and *costata*), are founded upon as little variation in the number of the radii, or costæ.

2. The radii on the *gigantea* are the same width as the intermediate spaces, and have much the same appearance as those on an *Ambonychia radiata*, while the radii on the *alata* are *nearly* equal in breadth to the furrows between, but those on the central portions of the valves pass nearly straight from the beaks obliquely to the posterior basal margin, while those on the anterior side curve forward below, and those near the cardinal margin curve upward behind. Here is a very important distinction, for while the radii curve on the *alata*, the spaces between them grow wider and wider, but they increase very little in width, if at all, as plainly appears by the figure of Prof. Meek, referred to above; thus differing widely from the *Ambonychia radiata* and the *gigantea*, as shown by the description and figure above referred to. Indeed, no other shell of the same, or an allied genus, found in the Cincinnati Group, possesses this peculiarity in the same degree as the *alata*.

3. The *gigantea* is marked exteriorly, toward the margin, with lines of growth, while the *alata* has at regular distant intervals a few strongly defined, imbricating marks of growth, that curve parallel to the basal and posterior margins. There is no resemblance at all between the two species in this regard, and this ought to be apparent to any one, as well from the descriptions as from a view of the engravings; but, for the purpose of enlightening the Professor upon this speci-

fic difference, as he, probably, has never had the pleasure of seeing either species, I will add, that there are no imbricating lines of growth on the *gigantea*, except near the margin, and that they lie flat upon the shell and are not visible on the interior part of the shell, and are not, therefore, preserved on casts of the interior. While the imbricating lines on the *alata* are placed at regular intervals across the shell, as shown by Prof. Meek's figure. They do not always lie flat, but frequently curve up, so as to allow a knife blade to be introduced between the two parts of the shell, and when viewed on the interior, one part of the shell appears as if laid upon the other, like clapboard shingles on a log school-house, and the depression incident thereto produces a corresponding elevation on the casts. This difference alone is sufficient to characterize the species.

But, the Professor says, that "Mr. Miller seems to have relied solely upon the large size and the preservation of concentric striæ of his shell to separate it from *M. alata*." I do not know where the Professor acquired this information, for I certainly never entertained or expressed any such views, or wrote anything to warrant any such inference. The declaration is, therefore, not only untrue, but wholly gratuitous. The only comparison made with the *A. alata*, consisted in the bare statement, that it was readily distinguished by the surface markings. And so it is, as shown by the descriptions, and by the engravings, and the fact is plain to every one who has seen the specimens; and, lest the Professor should be of the same opinion still, it may be proper to state that the concentric striæ referred to are common to the *Anomalodonta gigantea*, *A. alata*, *Ambonychia radiata*, and other species belonging to these genera.

As it must be quite evident to every one, that the specific differences between the *alata* and *gigantea* are obvious, from an exterior or interior view of the shells, and may be detected in the casts, we will pass on to the other points made by the Professor, where the blunders, if not so apparent, are yet quite as bold.

In the July number of this Journal, page 211, some doubt is expressed about classifying such equivalve shells as the *Anomalodonta* and *Ambonychia* in the inequivalve family *Aviculidæ* and a comparison is drawn between the hinge lines of the *Anomalodonta* and *Myalina*. One can hardly help thinking that the Professor has read this, though he don't say so.

The learned paleontologist, Prof. McCoy, placed the genus *Ambonychia* in the family *Aviculidæ*, but only casts were then known, and he *supposed* it to be an inequivalve shell, and lesser Professors since his time have continued the same classification, without apparent examination; notwithstanding that, it does violence to every family characteristic of the *Aviculidæ*, save the attachment by a byssus, which is not, by any means, peculiar to that family. Receiving nothing in science through faith, though only an amateur, I shall retain my infidelity, until some reason is given for such classification. It is not, therefore, sufficient to say, they "*evidently belong to the family Aviculidæ*," but rather self-sufficient and pedantic in a critic.

The Professor asserts the improbability of the situation of the muscular impression in a shell that he has never seen, from reading a description and looking at an engraving, that would seem to be wholly incomprehensible to him; but notwithstanding the "monstrous improbability of the possibility" of his comprehending it, it is nevertheless a fact, that the muscular impression is neither too large nor in too low a position. Nor is it larger in proportion, or placed in a lower position than the muscular impression of an *Ambonychia*. It may be a fact, however, that the engraving makes the muscular impression appear to hug the anterior part of the shell rather too closely; if so, it is because the engraving does not clearly define the line of separation. This, however, can not mislead any one, and practically amounts to nothing.

We now come to the consideration of the generic name. It is here that the Prof. seems to have done his best at misrepresentation, and for what purpose I am at a loss to comprehend. What are the facts? Let us look at the 3d volume of the Geological Survey of Illinois, pages 337 and 338. We here find that Meek and Worthen proposed the subgeneric name *Megaptera* and specific name *Casei*, for a shell of which they said, "It has the hinge teeth (at any rate, those just in front of the beaks) of *Ambonychia*," and they said "we have concluded to leave it provisionally under *Ambonychia*." Consequently the shell was named "*Ambonychia* (*Megaptera*) *Casei* (M. & W.)" Nothing can be clearer than the fact, which may be soon ascertained, that if this *Casei* has the lateral teeth of an *Ambonychia*, it will be simply an *Ambonychia Casei*. It can never be an *Anomalodonta*, because it has the cardinal teeth of an *Ambonychia*. In 1872, Prof. Meek published a description, on page 319 of the Proceedings of the Phil. Acad. Nat. Sci., of *Ambonychia* (*Megaptera*) *alata* and appended to it a note, the whole of which was republished on page 131 of the Ohio Paleontology, in 1873. In the note so published in 1872, after showing that the name *Megaptera* had been preoccupied, Prof. Meek says, "If it should be thought desirable to substitute another name for this group, typified by *M. Casei*, and the species here described, I would propose to call it *Opisthoptera*." In 1873, Prof. Meek still retained his names, *Ambonychia* (*Megaptera*) *Casei* and *Ambonychia* (*Megaptera*) *alata*, and never used or adopted the name *Opisthoptera*, which, in 1872, he said, "*if it should be thought desirable*" he "*would propose*."

The name *Opisthoptera*, then, has not become a paleontological term, and when it is "thought desirable" Prof. Meek may propose to use it, as Meek and Worthen proposed to use *Megaptera*, for shells having the cardinal teeth of *Ambonychia*; but he never can propose to use it for shells having the cardinal tooth and hinge line of the *Anomalodonta*.

In January, 1874, I made and clearly defined the genus *Anomalodonta*, for shells having a peculiar hinge line, before wholly unknown, founded upon the species *A. gigantea*. From part of a hinge line of *A. alata*, in the possession of Mr. James, I ascertained that its cardinal teeth were not those of an *Ambonychia*, but were peculiar to the *Anomalodonta*, and, from the general shape of the shell, I then believed what I am now more fully assured of, that the hinge line of the two species was substantially the same, and, consequently, that the *Ambonychia alata* would become the *Anomalodonta alata* (Meek). At that time, I suggested that the genus *Anomalodonta* would, *probably*, include the *Ambonychia* (*Megaptera*) *Casei*, but I am now of the opinion that the character of its cardinal teeth alone exclude it. I believe, however, with Prof. Meek, that it may become the type of a new subgenus under *Ambonychia*, because its lateral teeth, though unknown, are probably different from the true *Ambonychia*. I do not, however, from the statement of Prof. Meek, think that it can wear the name *Megaptera* according to the rules of nomenclature, nor the name *Opisthoptera*, until actually proposed and used by somebody.

As to *Megaptera*, it having been previously used for a genus of whales, it can not be used for the generic name of shells, under the tenth rule of the British Association for the Advancement of Science, which is now a law to all naturalists; this rule and the reasons for its adoption are as follows:

"It being essential to the binomial method to indicate objects in natural history by means of *two words* only, without the aid of any further designation, it follows that a generic name should only have one meaning; in other words, that two genera should never bear the same name. For a similar reason, no two species in the same genus should bear the same name. When these cases occur, the latter of the two duplicate names should be canceled, and a new term, or the earliest synonym, if there be any, substituted; when it is necessary to form new words for this purpose, it is desirable to make them bear some analogy to those which they are destined to supersede, as where the genus of birds, *Plectorhynchus*, being preoccupied in ichthyology, is changed to *Plectorhampus.* It is, we conceive, the bounden duty of an author, when naming a new genus, to ascertain by careful search that the name which he proposes to employ has not been previously adopted in other departments of natural history. By neglecting this precaution, he is liable to have the name altered and his authority superseded by the first subsequent author who may detect the oversight, and for this result, however unfortunate, we fear there is no remedy, though such cases would be less frequent if the detectors of these errors, would, as an act of courtesy, point them out to the author himself, if living, and leave it to him to correct his own inadvertencies. This occasional hardship appears to us to be a less evil than to permit the practice of giving the same generic name *ad libitum* to a multiplicity of genera. We submit, therefore, that

"Sec. 10. A name should be changed which has before been proposed for some other genus in zoology or botany, or for some other species in the same genus, when still retained for such genus or species."

The law of nomenclature, having disposed of *Megaptera,* reaches out its hand and suppresses, at least for the present, *Opisthoptera.* Because only one of the authors suggested the name with an if and a doubt, and did not himself adopt it, as plainly appears by reference to the publication in the Ohio Paleontology, above referred to, and if he had positively proposed the name, it would have fallen under the twelfth rule governing naturalists, and the reasons therefor, as follows:

"Unless a species or group is intelligibly defined when the name is given, it can not be recognized by others, and the signification of the name is consequently lost. Two things are necessary before a zoological term can acquire any authority, viz., *definition* and *publication.* Definition properly implies a distinct exposition of essential characters, and in all cases we conceive this to be indispensable, etc." Therefore:

"Sec. 12. A name which has never been clearly defined in some published work, should be changed for the earliest name by which the object shall have been so defined."

The only generic characters ever given to *Megaptera,* and consequently the only ones that *Opisthoptera,* if alive, can inherit, are the cardinal teeth of an *Ambonychia,* and a long posterior wing; and the right of possession of these is dependent upon ascertaining that the lateral teeth in the posterior wing of the *Casei* is essentially different from the lateral teeth in the posterior wing of the *Ambonychia.* And if possession is ever acqured, the characters will only be subgeneric, and will include, so far as yet ascertained, but one species, whose name will then be *Ambonychia* (*Opisthoptera*) *Casei* (M. & W.)

The genus *Anomalodonta,* having a cardinal tooth and hinge line wholly different from the *Ambonychia*, can never be affected by it or any subgenus under it. So far, then, as anything is yet known the genus *Anomalodonta* will hold its place in the zoological column, represented by at least two species, *Anomalodonta gigantea*, the type, and *Anomalodonta alata*.

Descriptions of New Species of Brachiopoda, from the Lower Silurian Formation, Cincinnati Group.—By U. P. James.

Strophomena gibbosa—James.

S. gibbosa—James. Catalogue of Lower Silurian Fossils, Sept. 1871.

Shell fragile, semi-oval; cardinal line extended to or a little beyond the width of the shell farther forward, deflected at the extremities; lateral and front margins regularly rounded. *Ventral valve* slightly convex in the umbonal region, but at about one third or one half the distance from the beak, toward the front and lateral margins, it curves suddenly upward, then rounds off, and is deflected as suddenly the other way to the front and sides, forming a high rounded ridge, giving to the shell a decidedly gibbous form; this hump extends to about $\frac{1}{8}$th of an inch of the cardinal line on each side, where the shell is rather depressed from the umbonal slopes outward to the deflected extremities immediately in front of the cardinal line; cardinal area linear; beak rather prominent, projecting, minutely perforated; six to eight slight wrinkles on the umbonal region. Surface covered by fine radiating striæ, increased by interstitial additions, somewhat variable in size on the front slope, but quite uniform on the umbone and to the lateral margins; crossed by fine concentric striæ. Interior not observed.

Dorsal valve (exterior) gently concave to about the middle, where it makes a sudden curve, conforming to the shape of the other valve; the two valves are so closely drawn together as to leave scarcely any visceral space; beak very little elevated above the cardinal line; area no more than a rather sharp edge of the hinge; radiating striæ, as far as observed, same as on the ventral valve. *Interior* nearly flat, or slightly convex, to the base of the ridge in front, and laterally to within about one quarter or one eighth of an inch of the cardinal line, where there is a flat depression extending to the lateral margins; the curve to the front from the top of the ridge is abrupt, corresponding to the exterior; cardinal process bifid, erect, rather prominent, curving slightly anteriorly, crenulated posteriorly, and sloping in the same direction; socket ridges short, crenulated, oblique; rounded, low, wavy elevations just beyond the points and in front of the socket ridges; a small but rather deep pit immediately in front of the cardinal process, from which extends a low mesial ridge to about the middle of the shell forward, where it fades out; the concentric wrinkles of the exterior show through slightly, and the radiating striæ plainly, with small, but distinct, radiating rows of papilla, which are rather distant from each other, to the ridge, but crowded together on the front slope and toward the lateral margins; no muscular scars observed.

Width of a specimen of medium size, measuring from the points of the hinge line, $1\frac{1}{8}$th inch; length, about three fourths of an inch.

Position and locality: Cincinnati Group, about eighty feet above low water-mark of the Ohio river, at Cincinnati. Collected by U. P. James.

Specimens of this shell were submitted to Mr. Meek, when he was making up his report for the first vol., part ii., of the Paleontology of Ohio. He considered it a variety of *Strophomena rhomboidalis*, Wilckens. Probably the material now at hand is better than he had for comparison. *Strophomena tenuistriata*, Sowerby, he placed also as a variety of *S. rhomboidalis*, and identical with *S. gibbosa*. Between these three forms there seems to be wide variations. Some of the differences are:

The shell of *S. tenuistriata* is much thicker, the concentric wrinkles stronger, and the radiating striæ much coarser than *S. gibbosa*, and the umbone more prominent. The interior of the dorsal valve of *S. gibbosa*, viewed posteriorly, shows the bifid cardinal process as erect and at right angles with the plane of the shell, whilst it curves or leans outwardly in the case of *S. tenuistriata*, and viewed from the front of the shell the two parts are more spreading in *S. tenuistriata* than *gibbosa*; the socket ridges much shorter and less prominent in *tenuistriata* than *gibbosa*; there is scarcely any depression immediately in front of the cardinal process of *tenuistriata*, where the pit is quite decided in *gibbosa*. Owing to the frail structure of the shell I have not been able to procure a good interior view of the ventral valve of *gibbosa* for comparison, but the differences stated, together with the fact that S. *gibbosa* is found only at a horizon about 80 feet above low water-mark of the Ohio river at Cincinnati, and *S. tenuistriata* some 400 feet higher in the rocks, and none of either species, that I have ever heard of, occurring anywhere within or between these horizons, would seem to justify its being placed as a distinct species. At any rate, if considered as varieties only, they mark distinct horizons in the rocks in the west, each holding its place constantly—*S. gibbosa* the lower part of the Cincinnati Group (Lower Silurian), *S. tenuistriata* the upper part, and *S. rhomboidalis* in the Upper Silurian (Niagara Group).

The material I have at hand from the Niagara Group of Indiana shows a still more marked difference between *S. rhomboidalis* and *S. gibbosa* and *tenuistriata*, than between the two latter, in almost every feature, but more especially the internal structure.

Strophomena squamula—(James).

S. squamula—James. Catalogue of Lower Silurian Fossils, Sept. 1871.

Shell small, thin, semi-oval in outline, broader than long; hinge line varying from a little more to a little less than the greatest breadth of the shell farther forward.

Dorsal valve slightly concave or nearly flat; cardinal line straight: cardinal area linear; a slight depression immediately forward of the beak. Surface covered, with fine, rounded, radiating striæ of nearly uniform size, increased toward the free margins by bifurcation.

Ventral valve slightly convex; beak and hinge line slightly projecting; cardinal area narrow, a little the widest in the middle; foramen triangular and nearly closed by the cardinal process of the other valve: a strong mesial rib extending from the beak to the front; surface covered by fine, rounded, radiating striæ, which bifurcate once or twice before reaching the free margins; the striæ starting at and near the beak more prominent than the branching ones; crossed by very fine concentric lines, visible only under a good magnifier, and even then in some cases quite obscure. Visceral space very little, the valves being so closely drawn together, translucent. Interior not observed.

Breadth of a full sized specimen, $\frac{5}{8}$ths of an inch; length, $\frac{1}{2}$ an inch.

Position and locality: Cincinnati Group, about 350 feet above low water-mark of the Ohio river, at Cincinnati.

Collected by U. P. James.

On the so-called Land Plants from the Lower Silurian of Ohio; by J. S. Newberry. [From the American Journal of Science and Arts, August, 1874.]

In the January number of this Journal [republished in the January number of this Journal, page 43], Mr. Leo Lesquereux describes two fossils found in the upper portion of the Cincinnati Group, near Lebanon, Ohio. These he considers as the remains of land plants, and refers them to the genus *Sigillaria;* and this case is cited as the first instance where plants so highly organized have been met with in Lower Silurian rocks. Through the kindness of the Rev. H. Hertzer, to whom the specimens in question belong, they had been in my possession some time before the publication of Mr. Lesquereux's notice, and I had examined them with some care, for the purpose of determining, if possible, their botanical relations. I had also made careful drawings of them, of which copies are herewith submitted. As the result of my examination, I am compelled to say that I fail to find, either in the external characters or internal structure of these specimens, any satisfactory evidence that they represent land plants; still less, that they form species of the genus *Sigillaria.* Their external markings are fairly represented in the accompanying figures [here omitted because not necessary to a full comprehension of the subject], and they exhibit no internal organic structure whatever. They are simply casts in earthy limestone, without carbonaceous matter or any traces of woody tissue.

The smaller specimen is a discoid section of a cylindrical trunk, of which the external surface is very smooth, but is marked by a reticulation not unlike that of one section of the genus *Sigillaria.* I did not discover, however, any dots or tubercles in the center of the meshes, such as are referred to by Mr. Lesquereux, and which, were they present, might be supposed to represent the place of the nutrient vessels of the leaves. Taken by itself, I should say that this specimen might be a sponge, or some other low form of marine life, quite as well as a *Sigillaria.* Since it is so small and forms so little of the original organism, I think it would be unsafe to make it the base of any general and important conclusion.

The larger specimen is represented, like the other, of natural size. This is also a cast of a nearly cylindrical trunk, of which the external surface is roughened by irregularly disposed and unequally sized lenticular prominences. These resemble, in a rude way, the leaf scars borne by the trunks of some lycopodiaceous or cycadaceous plants, but they do not exhibit the spiral arrangement, nor the details of structure which the leaf-scars of such plants almost uniformly retain in the fossil state. In the interior of this trunk are seen a few of the irregularly scattered points of carbonaceous matter, but they are not continuous fibers, and to my eye show no traces of cell structure.

Taking all the characters of these interesting fossils into consideration, I am disposed to regard them as casts of the stems of fucoids. Had they been land plants, they would almost certainly exhibit more distinctness and regularity of surface marking, some coating of carbonaceous matter, and some traces of organic structure. A large number of specimens of sea-floated land plants, which we have found in the Devonian limestones of Ohio, all assert their botanical affinities by these characters. The remains of fucoids, on the contrary, consist almost universally of mere casts of their external surface, carbonaceous matter and internal structure having both entirely disappeared.

The physical condition of the region about Cincinnati, during the Lower Silurian age, strengthens the conclusion that the specimens under consideration are not the remains of land plants. As I have shown elsewhere,* the Cincinnati arch was raised at the close of the Lower Silurian age. Subsequent to that time it formed a group of islands, which, during the Devonian age, were probably covered with luxuriant terrestrial vegetation. But during the period when the Cincinnati Group was deposited an open sea occupied all this part of the Mississippi Valley. The shores of this sea were formed by the Blue Ridge, the Adirondacks, the Canadian Highlands, and the Eozoic area on the south shore of Lake Superior, nowhere nearer than 500 miles from the locality where these specimens were found. In these circumstances we must regard it as extremely improbable that specimens of two species of land plants should be floated from this far-off shore, and should be deposited together in the calcareous sediment accumulating at the sea bottom, near where Cincinnati now stands. That fucoids should be found there is, however, not at all strange, for they float to all parts of all oceans, and other fucoids are frequently met with in the Cincinnati Group of this vicinity.

For the reasons given above, I should hesitate to rest upon these specimens so important a conclusion as that promulgated by Mr. Lesquereux. I would not be understood, however, to assert positively that they are *not* the remains of land plants, for they are too imperfect to be decisive of that question, but only this, that they do not afford characters which permit me to accept them as evidence of the existence of land plants, and certainly not of *Sigillariæ* in Ohio, during the Lower Silurian age.

The remains of what have been called land plants have been discovered in the Lower Cambrian sandstones of Sweden, and two species of these have been described (*Eophyton Linneanum*, Torell, and *E. Toreli*, Linnarsson). The specimens are said by all geologists not to be the remains of algae, but they are considered to be vascular cryptogams or monocotyledons. It is not certain, however, that they are not thallogens, as all traces of structure are lost, and nothing is left but the impression of the external surface.

* Geological Survey of Ohio, vol. i, part i, page 93.
[In September, 1871, I read an essay before the Cincinnati Society of Natural History, to show there was an island elevated in this locality, at the close of the Lower Silurian period, which I called the island of Cincinnati. The same view, however, was entertained by several geologists long before the Ohio survey had an existence.—Ed.]

The evidence of the existence of land plants during the Upper Silurian age is more satisfactory. Prof. J. W. Dawson, of Montreal, has announced the discovery of vascular cryptogams in the Upper Silurian strata of Gaspe, Canada. Here, with a large number of fucoids, a few specimens have been found, which he refers to his genus *Psilophyton*. In these the scalari-form axis and the outer fibrous bark both remain, and serve as guides in their classification.

With these exceptions, no land plants are reported below the Devonian. On this point, however, the evidence is all negative, and highly organized land plants may be at any time found in the Lower Silurian rocks. Indeed, the variety and high rank of the Devonian flora prepares us to expect such a result. Strict accuracy compels us to state, however, that up to the present time positive proof of the existence of land plants in the Lower Siluran has not been met with in other countries, nor is it furnished by the specimens under consideration.

Notes and Errata on a former paper, by V. T. Chambers, *on Prof. Frey, and some American Teneina.**

Correction of the typographical errors in the article by V. T. Chambers, Esq., on Prof. Frey, and some American Teneina, viz:

Page 195, line 15, for "as" read "and;" and line 24, for "Ball" read "Boll."

Page 197, line 3, for "colabour" read "colaborer;" and line 21, omit the word "undescribed."

Page 199, line 6, for "Holland" read "New Holland;" and line 30, for "*malifoballa*" read "*malifoliella*."

Page 200, line 24, for "this" read "his;" and in the last line for "*paradadoxum*" read "*paradoxum*."

Page 203, line 22, for "*larvæ*" read "*larva*."

Page 206, line 20, for "*lespedezia*" read "*lespedeza;*" and same page, line 34, for "noun" read "name."

Page 207, line 10, for "*helianthum*" read *helianthemella*."

Page 208, line 15, for "*larvæ*" read "*larva*;" line 22, for

* The typographical errors which have occured during the year, are generally such as are quite manifest to the reader. A few occurred where the proof was not read by the editor, for instance Palæomanon on page 192 misspelled Palæmanon.

"Bollo's" read "Boll's;" line 28, for "new" read "mere;" line 36, for "*galechifa*" read "*gelechia.*"

Page 209, line 4, from bottom, for "midriff" read "midrib."

Mr. Chambers adds to the list of plants, on which he has found *Tischeria malifoliella* feeding, the dewberry, *Rubus canadensis*, found since the publication of the July number, and further says:

When my former paper was written, I was led, from the fact that Prof. Frey gives *Parectopa robiniella*, Clem., as a synonym of his *Lithocolletis gemmea*, and from the best understanding that I could then get from his description, to believe that he had specimens of *P. robiniella* before him, and that he was simply redescribing *P. robiniella*, Clem., as *L. gemmea*, Frey, and I was fortified in this conclusion by the fact that under his description of *L. gemmea* he remarks, that "the mines of *Robinia pseud accacia*" (Black Locust), "consist of a common *Lithocolletis* dwelling, with a smooth edge, in which the caterpillar is transformed." (This is certainly the mine of *Lithocolletis robiniella*, Clem.); "or, again, in a digitated mine of the upper side" (which is evidently the mine of *Parectopa robiniella*, Clem.); "or, thirdly, in an upper and under side mine of rounded not much serrated shape," (which is very clearly the mine of *Lithocolletis ornatella*, Chamb.) All these mines, and the larvae which inhabit them, and the insects bred from them have been thoroughly known to me for years. *L. robiniella* and *P. robiniella* were thoroughly known to Dr. Clemens, and so was *L. robiniella*, and the mine and larva of *L. ornatella* to Dr. Fitch. These mines and insects are found all over the United States, where the locust tree is found, and no other mines except those of the butte *Hispa suturalis*, have ever yet been found in locust leaves, though they have been made the objects of careful investigation from New York and Minnesota to New Orleans.

It is evident, however, from a closer study of Prof. Frey's paper, that his identification of *P. robiniella*, with *L. gemmea*, as described by him, is very wide of the mark. *P. robiniella*, Clem., *can not possibly be identified* with either of the forms described by Prof. Frey, under *L. gemmea*. These forms appear to me to be much nearer to *ornatella*, than to *Parectopa robiniella*, or to *Lithocolletis robiniella*. Indeed, a specimen of *L. ornatella*, with the second fascia interrupted in the middle, *might* pass for *L. gemmea*, but for the white-tipped antennæ and spot at the apex of the wings, which Prof. Frey gives to his *L. gemmea*. I do not think, however, that it can be a variety of *ornatella*. Prof. Frey evidently had the "digitated mine" of *Parectopa robiniella*, Clem., before him, but just as evidently he did not breed that species from them; at all events he has not described it in his *brochure*, nor anything approaching to it. The only point in which *L. gemmea*, as described by Prof. Frey, seems to resemble it is the white tips to the antennæ. In no other respect does his description apply to *P. robiniella.* What then is *L. gemmea*, Frey? It seems to me that Prof. Frey, is mistaken in supposing that it was bred from locust leaves. Such a mistake might well be made in such a confused jumble of leaves as Prof. Frey had, and as it is certainly neither *P. robiniella* nor *L. robiniella,* it must, if bred from the locust, be either a variety of *L. ornatella*, or a new species. The description scarcely admits the first of these alternatives. But if it is a new species, I do not think it can be a leaf miner of the locust, in view of the close study and observation which the locust miners have received in this country. The confusion of Prof. Frey's different kinds of leaves, and the fact that he only mentions the three mines in locust leaves, which were already known to belong to *L. robiniella*, *L. ornatella*, and *P. robiniella.* I think, then, that *L. gemmea* is not a locust leaf miner, and for the present it is impossible to say whether or not it has been previously described. Very certainly it is not *P. robiniella,* Clem., nor anything like it. At present it is utterly unknown and unknowable to everyone, save Prof. Frey.

In addition to what has been formerly said, as to whether *P. robiniella,* Clem., is or is not properly a *Gracilaria,* I will add, that the position of the legs in the living specimens is the same as in *Gracilaria,* though the anterior portion of the body is scarcely so much elevated as in larger species of *Gracilaria,* and the pattern of coloration closely resembles that of *G. salicifoliella,* Cham., and less closely *G. kollairella,* Zell.

On the Parallelism of Coal-Seams.—By E. B. Andrews. [From the American Journal of Science and Arts, July, 1874.]

In the April number of this Journal [republished in the July number of this Journal, page 267], Dr. Newberry calls in question my views of the general parallelism of coal-seams, derived from the study of our Ohio coal-measures, and thinks them not only "untrue" but "calculated to do positive and pratical harm." The only point of difference between us, of any interest to science, is, whether the ancient shore lines, with their coal-marshes, subsided in an even and uniform way, or very unevenly, so as to bring each marsh to greatly varying depths below the water level. I am led to hold the former opinion, while he strenuously maintains the latter. In my district, and in the portions of his district—*i. e.*, the one under his special supervision—that I have examined, and also in the bordering States of West Virginia and Kentucky, I find a general parallelism of the seams of coal, implying an even and uniform subsidence. This makes system possible and stratigraphy useful in our coal-measures. If, on the other hand, the subsidence were uneven and irregular, no coal-seam can have its proper and exact horizon, and all things are in confusion. If, for example—and I quote one of the cases given by Dr. Newberry in his article—coals No. 8 and No. 9 are, at one place, 150 feet apart, and have three coal-seams, 8*a*, 8*b*, and 8*c*, intercalated between them, and a few miles away they are only 50 feet apart, with no intercalated seams, the mind is left in confusion and perplexity, and the practical identification of coal-seams is well nigh impossible. The theory of unequal subsidences, of "very local subsidences," of "warped and folded strata," is itself very confusing, for it requires us to believe that the old shore areas held themselves in statistical equilibrium near the water's edge, during the long periods in which the vegetable matter of the coal-marshes was accumulating, and then settled below the water level with all sorts of pitches and irregularities. That there could be such alternations of perfect rest and equipoise, with irregular and lawless subsidence, in a region never disturbed by igneous or other forces which have left any traces of themselves, appears theoretically highly improbable. According to Dr. Newberry's published sections, while his coal seam No. 5 settled down 20 feet in one place, it settled in another 130 feet, and further on, in the same direction, only 32 feet. Among the illustrations and proofs of this confusion-theory adduced by Dr. Newberry, is the varying distance between his coal seams No. 1 and No. 2. That the Briar Hill, or lowest seam in Mahoning and Trumbull counties, is very irregularly bedded, I readily concede. It was laid down in patches and strings in the depressions of an uneven surface of Waverly or conglomerate, a surface which had probably been long subjected to subærial erosion. When this very undulating surface, with the coal-swamps filling its basins and winding hollows, subsided below the ocean, the introduction of the proper coal-measure stratification began, and then occur horizontally arranged sediments. Hence, the next seam of coal above is, according to Mr. Reed, in a "perfectly horizontal position" over areas where No. 1 shows great irregularities. Now, what I should expect in northeastern Ohio, would be this: That all the subsequently formed seams of coal would be formed under the conditions of No. 2, and not after the manner of No. 1, whose conditions are entirely exceptional. The lowest seam of coal in Jackson county, in my district, is similarly uneven; but the next seam above—the Anthony seam—is perfectly regular and uniform, and in parallelism with all the seams above it. This parallelism is turned to practical account in the sinking of shafts and other explorations for seams of coal. The position of one being known, that of the rest is known. With the other alleged proofs of irregular subsidences I have no personal knowledge, excepting of the case drawn from the region of Belmont and Guernsey counties, directly bordering my district. This is the case already referred to where coals No. 8 and No. 9 approximate, with a loss of three intercalated seams, viz.: 8*a*, 8*b*, 8*c*. I have especially investigated this case, and find no tendency to convergence between No. 8 and No. 9. Everything proceeds westward regularly. For example, the (so-called) intercalated seam No. 8*c* is one of the great and continuous seams of my district, and sweeps through county after county, always 85 to 100 feet above No. 8, or the Pomeroy seam. Now, if the plane of seam No. 9, starting on the Ohio river, near Wheeling, at an elevation of 150 feet above No. 8, gradually dips to within 50 feet of No. 8, cutting the plane of the great seam, 8*c*, in its passage, we have in this the most wonderful fact in all the stratigraphy of coal-fields. The faith of scientific men in this fact will be livelier when Dr. Newberry points out the line of intersection of the two coal planes. I have used his numbering of the coal-seams. There is very great difficulty in accurately numbering our Ohio coal seams, if we begin at the base of the series, since such are the inequalities of the surface of the Waverly that coal No. 1 in one place is not coal No. 1 in another, and, consequently, sections taken at different points, and, especially, if so taken by different men, working without concert and not collating their work in the field, will be very conflicting. The makeshift of "intercalated seams" only adds to the confusion.

Dr. Newberry's method, of condemning my views on the authority of names, is one often used, but it has no place in science. I could adduce many and great names in favor of my theory of general parallelism. Of course I do not claim parallelism in any absolute or mathematical sense, for no marsh would constitute a perfectly even plane; and in the subsequent compression of the sediments between seams of coal, the oozy mud in one place would be more compressed than the sands of another. This would give a little undulation to the planes of the coal-seams. I have recently found some interesting illustrations of this. But I hold to a general and well-marked parallelism, such as makes the stratigraphy of our coal-fields a system of symmetry and beauty, and of the highest practical value to all who wish to know the location and range of coal-seams.

Genus *Megalograptus*—(S. A. Miller).

[*Etym.*—Gr. *megale,* great; *graptos,* writing; in allusion to the remarkably large size of the polyp.]

Generic characters.—Body large, cylindrical, or subcylindrical, covered with polyp cells, and bearing fronds with spinous processes. In the absence of more than detached pieces of the typical species, *Megalograptus Welchi,* reference to its characters are necessary to a very clear comprehension of the genus.

Megalograptus Welchi—(S. A. Miller).

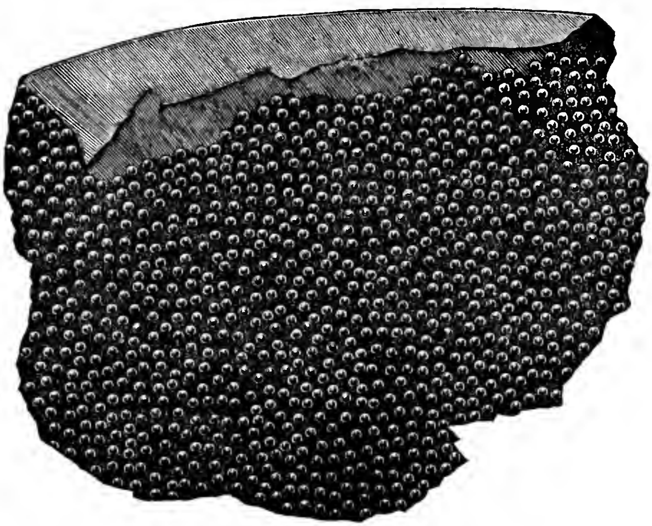

Fig. 35—*Megalograptus Welchi.* Cylindrical part of the body showing polyp cells.

Body large, cylindrical, or subcylindrical and covered, like all other graptolites found in the Cincinnati Group, with a jet black film of carbonaceous matter, which readily burns in a flame. Over the outer surface there are numerous irregularly distributed circles of the film, which I regard as the compressed cells of the polyp. Fig. 35 represents a specimen, three inches in diameter, and a little over two inches in length. It has been compressed to about one half an inch in thickness, but the compression has not so destroyed the edges, as to prevent the tracing of the entire circumference. The cells, as shown in the figure, though not any too numerous, yet, on account of the white color, appear more brilliant than they do in the specimen, and the same may be said of the cells on figures 36 and 37. This, however, was unavoidable, and is probably not *very* objectionable.

The connection of the parts shown by figures 36 and 37, with the cylindrical part of the body, has not been observed, but, from the numerous fragments of all parts, found crowded together in the blue

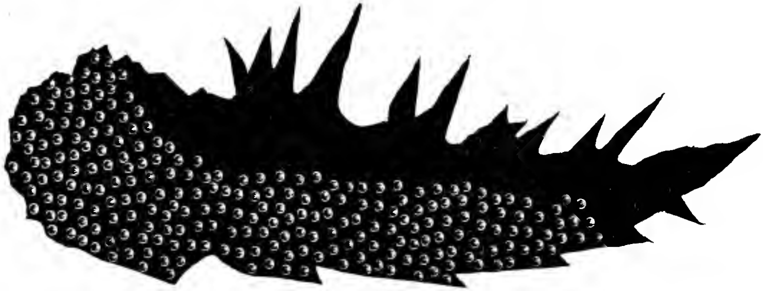

Fig. 36.—*Megalograptus Welchi.* Frond showing the spinous processes.

marl, and the appearance of the large end of the best preserved fronds, and the broken appearance of the ends of the cylindrical part of the body, the conclusion seems almost inevitable, that they form part of the same animal.

Figure 36 represents a frond from the collection of Dr. L. B. Welch. It was evidently somewhat conical in shape, though now flattened; the spinous processes were, too, like thorns, though now flattened. The frond seems to have been separated into sections, though the

Fig. 37.—*Megalograptus Welchi.* Frond showing the spinous processes.

section marks, which consist of mere depressions in appearance, are not shown in the figure. The first section mark crosses just below the first four spines, the next one from just above the four spines to the first saw-tooth-like projection, the next one from above the next cluster of spines to the next saw-tooth, and so on, to the top; thus dividing the frond into six sections. The first section is quite irregular, because of broken edges. The second section has four spines, one of which has its point directed downward, another has its point directed upward, and the other two are directed nearly at right angles to the frond. The projection, like a saw-tooth, on the opposite side, may have been produced by pressing together the body, which, at this place, was suddenly contracted. Indeed, the saw-tooth projections all seem to me to have been formed in this manner, and, therefore, to represent the amount of the contraction of the frond at each tooth. The spines, too, may not have been one above another, because compression would give them that appearance, whether they were in line or not, and one specimen examined indicates that they were not placed in line, one above the other, as they appear. The third section has evidently had one spine broken off from the lower side, and, therefore, had three spines, only two of which remain. The fourth section has the appearance of having had three spines, but the lower two represent a broken spine which was longer than the upper one. The fifth section has two spines, the upper one of which is the longest. The sixth section terminates in a spine at the top, and appears to have borne a spine upon the opposite side from the other spine. Part of the film has been decorticated from this specimen, and hence the exact surface covered by the cells could not be ascertained. It is quite clear, however, that the cells were not placed on or close to the spines, while they covered the greater part of the balance of the frond. The line separating the celluliferous part from the non-celluliferous part in the engraving is, therefore, only approximately correct.

Figure 37 may be separated into three sections: the lower one, having three spines, and being broken at the lower end, showing the film on the opposite side, and being compressed to one eighteenth of an inch in thickness; the second section has two spines; the third section may be somewhat fragmentary on the top. The part of this specimen showing the cells is quite clear, but some of the film is removed from the central part and toward the spines, consequently the cells may have extended nearer to the spines than they are shown in the figure.

Another specimen, at a point where it is one inch in diameter, bears five spines, two of which project downward, and two upward, the upward projecting spines being the longest. It is broken off an inch and a half below these spines, where it rapidly enlarges to one and a half inches in diameter.

The specimens were all found in a bed of blue marl, in the upper part of the Cincinnati Group, near Clarksville, Clinton county, Ohio, associated with *Glyptocrinus O'Nealli* and *Dendrocrinus Casei.* It has not been found elsewhere so far as known.

The specific name is given in honor of Dr. L. B. Welch, of Wilmington, Ohio, who first discovered the species and called attention to it. Moreover, he has been a collector of fossils and a student of paleontology for many years, and has a splendid cabinet of rare fossils belonging to this locality.

Lichenocrinus tuberculatus—(S. A. Miller).

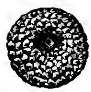

Fig. 38. *Lichenocrinus tuberculatus.* Enlarged nearly two diameters.

Body discoidal, circular in outline; lower surface, or surface of attachment, flat, or conforming to the surface to which it is attached; upper surface strongly convex or subhemispheric, with a deep circular depression in the central part, around the column; upper surface of body composed of numerous, irregularly arranged, thin, pentagonal or hexagonal plates, nearly uniform in size, smooth on the under side and highly convex or tuberculated on the outer surface. Excluding the plates immediately surrounding the column, within the central depression, which are much smaller than the others, the remainder will number about one hundred. Interior filled with upright lamelliform plates, radiating from a central point, on which the exterior plates appear to repose. Column pentagonal, length unknown.

Diameter of a medium-sized specimen $\frac{3}{12}$th inch, convexity $\frac{1}{12}$th inch; but Mrs. M. P. Haines, of Richmond, Indiana, to whom I am indebted for the specimen engraved, informs me that she has recently found specimens varying from $\frac{1}{12}$th to $\frac{6}{12}$th of an inch in diameter.

It is distinguished from *L. crateriformis*, which species it most resembles, by its tuberculated plates. It differs, too, in its greater convexity, more abrupt central depression, and greater uniformity in the size of its plates.

It is found in the vicinity of Richmond, Indiana, in the upper part of the Cincinnati Group. Small specimens, very closely resembling this species in general outline, are found near Clarksville, in Clinton county, Ohio, but differing, in the specimens examined, in this important regard, that the plates appear to be smooth instead of tuberculated.

The range of the three species of *Lichenocrinus*, thus far described in the Cincinnati Group, may be characterized, so far as known, as follows: the *crateriformis*, from low water-mark to 300 feet above; *Dyeri*, from 200 to 500 feet above; *tuberculatus*, if it should include the Clarksville specimens, from 500 to 800 feet above, but if the Clarksville specimens belong to a distinct species, then the *tuberculatus* must be confined to the upper 200 feet or less of the group.

Trematis Dyeri—(S. A. Miller).

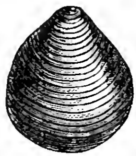

Fig. 39—*Trematis Dyeri.* Imperforated valve, enlarged about two diameters.

Shell elongate, subovate; valves unequally convex; upper or imperforated valve strongly convex; umbo projecting slightly beyond the margin; surface marked with twenty or more distinctly elevated, regular, concentric lamellæ, giving the valve a rough appearance. No punctations have been observed upon this valve, and no radiating striæ are visible upon the exterior or interior side. Lower or ventral valve slightly convex; umbo subcentral; surface punctate, and marked with concentric lines; oval slit, for the passage of the pedicle fibers of attachment, narrow, and situate between the umbo and projecting beak of the opposite valve.

Hinge and internal structure unknown. Length of specimen $\frac{2}{5}$th inch, and greatest breadth about $\frac{2}{50}$ths inch less.

The specimen engraved is from the collection of C. B. Dyer, Esq., in whose honor I have given the specific name. He found it on the hill back of Cincinnati, but its range is unknown. It is an extremely rare fossil.

Beyrichia Richardsoni—(S. A. Miller).

Fig. 40—*Beyrichia Richardsoni.* Magnified 6½ diameters.

Shell small, somewhat rectangular, rounded at each end, and truncated obliquely at the dorsal angles; narrow border on the ends and around the basal margin. A convex elevation rises on the dorsal margin, at the posterior end, crosses, parallel with the border, to the basal margin, and running along the basal margin, gradually enlarging, terminates in a somewhat tuberculous elevation at the anterior end. Another convex elevation rises on the dorsal margin, within the posterior third, and crossing the valve at right angles, terminates within the semi-elliptic curve formed by the preceding elevation. Tubercle rises like a little cone near the dorsal margin and line of the anterior third.

Length of shell about 0.08 inch, breadth about 0.05 inch.

Found near Wilmington, in Clinton county, Ohio, in the upper part of the Cincinnati Group, at about the elevation of *Dendrocrinus polydactylus.*

The specific name is given in honor of Mr. J. M. Richardson, of Wilmington, the collector, who well deserves the compliment for his devotion to the science, energy as a collector, and unbounded generosity in the distribution of specimens among his paleontological friends.

Glyptocrinus Fornshelli—(S. A. Miller).

Fig. 41—*Glyptocrinus Fornshelli.*

Cup obconoidal, about one and a half times as high as wide, and tapering to the column. Basal pieces, five, pentagonal in outline, wider than high. First radial pieces much larger than the basals, heptagonal, nearly as wide as long, and inserted in the angles produced by the junction of the basal pieces. Second radials octagonal, as long as the first, but not as wide. The third radials are heptagonal in outline, about the same size as the second, and each supports upon its upper sloping sides the secondary radials.

There are five secondary radials, the first two of which are nearly as large as the primary radials ; the others much less.

The interradial series consists of one hexagonal piece in the first range, resting between the superior sloping sides of the first primary radials ; two in the second range ; three in the third ; and above these as many as twenty pieces irregularly disposed in ranges, varying in outline from pentagonal to heptagonal, and gradually becoming smaller as they approach the top of the cup. The inter-secondary radial areas are each occupied by a series of about twelve pieces ; the first piece is heptagonal in outline and rests between the upper sloping sides of the first secondary radials ; this is followed by a single hexagonal piece, which is followed by ranges of two pieces each, until the top of the cup is approached, when as many as three small pieces intervene between the secondary radials.

Each basal piece is marked with four converging lines on a side, one of which on each side reaches the base of the plate, the others approach each other but leave an open space through the middle, lined with small dots. From a subcentral point in the first radial, a depression runs through the angle of junction with the basal plates, upon each side of which are four diverging lines, forming a continuation of the lines marking the basal plates. These lines approximate a square with a depression running diagonally from corner to corner (from subcentral point of first radial to base of cup at the angle of the column), and having four parallel lines upon each side, shortening as they approach the corners. (These four parallel lines are the four converging lines on one side of the basal plate, and four diverging lines on the lower part of the first radial.) From the subcentral point of the first radial a line runs direct to the subcentral point (upper part) of the third radial, where it bifurcates, and, passing over the secondary radials, terminates in the free arms.

Each triangle on the radials, formed by one side of the plate, and lines drawn from the subcentral point to the angles, is marked with parallel lines at right angles to the side of the plate, leaving an open space from the center to the angles. These lines continue over on the interradial pieces, each one of which has a subcentral point, from which it is marked in like manner. The lines never cross each other, and seldom come together. A row of dots usually separates the ends of the lines as they approach each other. The entire cup is therefore ornamented with figures, formed by fine lines running diagonally in squares, rectangles, rhomboids, etc., or forming triangles; their angles being situated in the central or subcentral points of the pieces, or at their junction, making it the most beautifully sculptured crinoid known to the Cincinnati Group.

The arms begin to rise on the third secondary radial and become free on leaving the fifth, without a bifurcation. They rise vertically from the last attached brachial piece, and consist of a series of round wedge-shaped pieces, each of which supports a pinnule. They bifurcate on the twelfth piece from the third secondary radial, and again and again bifurcate from the twentieth to the fortieth piece. They are long, round, and smooth upon the outside. The pinnules are long and very closely arranged along the inner lateral margins of the arms; they are composed of joints four or five times as long as wide. The long, smooth arms, their frequent subdivisions, and the long, dense pinnules add very much to the exquisite beauty of this species.

The column is of full average size, compared with that of other species of the genus. It is sharply pentagonal and composed of alternately thicker and thinner pieces, the former of which project very slightly beyond the others; the perforation is distinctly pentagonal, but it is surrounded with a circular depression in each plate, which gives the column the appearance of being round and encased with pentagonal rings. In exposed and weather-worn plates the circular piece falls out, which has led some, on looking at detached plates, to suppose the perforation to be round.

Looking at this species from any point of view, our interest is at once excited. It is remarkable in the structure of its column, and this becomes more worthy of observation, when we reflect, that it is the only species in this genus having its column sharply pentagonal. It sends up its free arms above the cup, without a bifurcation, which is strikingly in contrast with *G. decadactylus* and *G. dyeri.* It possesses great beauty, being the handsomest fossil ever found in the Cincinnati Group, if, indeed, it is not the most exquisite ever found in the whole range of the Lower Silurian rocks of Europe and America. And, too, it is not a little remarkable that it should have remained unearthed and unknown through all the years of toil and search which this locality has undergone, and finally be discovered, within the past sixty days, by a young collector, in no inconsiderable abundance, in compressed masses, forming almost entire slabs or strata of rocks.

The specific name is given in honor of the discoverer, F. L. Fornshell, Esq., of Morrow, Ohio, who also furnished the specimen for illustration and description in this Journal. It was found in a branch of Todd's fork of the Miami, a few miles east of Morrow, in the upper part of the Cincinnati Group, associated with *Dendrocrinus caduceus*, *Cyrtolites dyeri*, and other fossils peculiar to that range. Fragments of the column, and plates from the cup, have been found at other places in that locality, but not elsewhere, so far as known.

Rules for Rendering the Nomenclature of Zoology Uniform and Permanent, reported and adopted at the Twelfth Meeting of the British Association for the Advancement of Science, held at Manchester, in June, 1842.

PART I.—RULES FOR RECTIFYING THE PRESENT NOMENCLATURE.

Limitation of the Plan to Systematic Nomenclature.—In proposing a measure for the establishment of a permanent and universal zoological nomenclature, it must be premised that we refer solely to the Latin, or systematic language of zoology. We have nothing to do with vernacular appellations. One great cause of the neglect and corruption which prevail in the scientific nomenclature of zoology, has been the frequent and often exclusive use of vernacular names in lieu of the Latin binomial designations, which form the only legitimate language of systematic zoology. Let us, then, endeavor to render perfect the Latin or Linnæan method of nomenclature, which, being far removed from the scope of national vanities and modern antipathies, holds out the only hope of introducing into zoology that grand desideratum, a universal language.

Law of Priority the only effectual and just one.—It being admitted on all hands that words are only the conventional signs of ideas, it is evident that language can only attain its end effectually by being permanently established and generally recognized. This consideration ought, it would seem, to have checked those who are continually attempting to subvert the established language of zoology by substituting terms of their own coinage. But, forgetting the true value of language, they persist in confounding the *name* of a species or group with its *definition*; and because the former always falls short of the fullness of expression found in the latter, they cancel it without hesitation, and introduce some new term which appears to them more characteristic, but which is utterly unknown to the science, and is therefore devoid of all authority. If those persons were to object to such names of men as *Long*, *Little*, *Armstrong*, *Golightly*, etc., in cases where they fail to apply to the individuals who bear them, or should complain of the names *Gough*, *Lawrence*, or *Harvey*, that they were devoid of meaning, and should hence propose to change them for more characteristic appellations, they would not act more unphilosophically or inconsiderately than they do in the case before us; for, in truth, it matters not in the least by what conventional sound we agree to designate an individual object, provided the sign to be employed be stamped with such an authority as will suffice to make it pass current. Now, in zoology, no one person can subsequently claim an authority equal to that possessed by the person who is the first to define a new genus or describe a new species; and hence it is that the name originally given, even though it may be inferior in point of elegance or expressiveness to those subsequently proposed, ought as a general principle to be permanently retained. To this consideration we ought to add, the injustice of erasing the name originally selected by the person to whose labors we owe our first knowledge of the object; and we should reflect how much the permission of such a practice opens a door to obscure pretenders for dragging themselves into notice at the expense of original observers. Neither can an author be permitted to alter a name which he himself has once published, except in accordance with fixed and equitable laws. It is well observed by Decandolle: "L'auteur même qui a le premier établi un nom n'a pas plus qu'un autre le droit de le changer pour simple cause d'impropriété. La priorite en effet est un terme fixe, positif, que n'admet rien, n'arbitraire, ne de partial." For these reasons, we have no hesitation in adopting as our fundamental maxim, the "law of priority," viz.:

§ 1. The name originally given by the founder of a group, or the describer of a species, should be permanently retained, to the exclusion of all subsequent synonyms (with the exceptions about to be noticed).

Having laid down the principle, we must next inquire into the limitations which are found necessary in carrying it into practice.

Not to extend to Authors older than Linnæus.—As our subject matter is strictly confined to the *binomial system of nomenclature,* or that which indicates species by means of two Latin words, the one generic, the other specific, and as this invaluable method originated solely with Linnæus, it is clear that, as far as species are concerned, we ought not to attempt to carry back the principle of priority beyond the date of the 12th edition of the "Systema Naturæ." Previous to that period, naturalists were wont to indicate species not by a *name* comprised in one word, but by a definition which occupied a sentence, the extreme verbosity of which method was productive of great inconvenience. It is true that one word sometimes sufficed for the definition of a species, but these rare cases were only binomial by accident and not by principle, and ought not therefore in any instance to supersede the binomial designations imposed by Linnæus.

The same reasons apply also to generic names. Linnæus was the first to attach a definite value to genera, and to give them a systematic character by means of exact definitions; and, therefore, although the *names* used by previous authors may often be applied with propriety to modern genera, yet in such cases they acquire a new meaning, and should be quoted on the authority of the first person who used them in this secondary sense. It is true that several of the old authors made occasional approaches to the Linnæan exactness of generic definition, but still these were but partial attempts; and it is certain that if in our rectification of the binomial nomenclature we once trace back our authorities into the obscurity which preceded the epoch of its foundation, we shall find no resting place or fixed boundary for our researches. The nomenclature of Ray is chiefly derived from that of Gesner and Aldrovandus, and from these authors we might proceed backward to Ælian, Pliny, and Aristotle, till our zoological studies would be frittered away amid the refinements of classical learning.

We therefore recommend the adoption of the following proposition:

§ 2. The binomial nomenclature having originated with Linnæus, the law of priority, in respect of that nomenclature, is not to extend to the writings of antecedent authors.

[It should be here explained, that Brisson, who was a contemporary of Linnæus, and acquainted with the "Systema Naturæ," defined and published certain genera of birds, which are *additional* to those in the 12th edition of Linnæus' work, and which are therefore of perfectly good authority. But Brisson still adhered to the old mode of designating species by a sentence instead of a word, and therefore, while we retain his defined genera, we do not extend the same indulgence to the titles of his species, even when the latter are accidentally binomial in form. For instance, the *Perdix rubra* of Brisson is the *Tetræ rufus* of Linnæus; therefore, as we in this case retain the generic name of Brisson and the specific name of Linnæus, the correct title of the species would be *Perdix rufa*.]

Generic names not to be canceled in subsequent subdivisions.—As the number of known species which form the ground work of zoological science is always increasing, and our knowledge of their structure becomes more complete, fresh generalizations continually occur to the naturalist, and the number of genera and other groups requiring appellations is ever becoming more extensive. It thus becomes necessary to subdivide the contents of old groups, and to make their definitions continually more restricted. In carrying out this process, it is an act of justice to the original author that his generic name should never be lost sight of; and it is no less essential to the welfare of the science, that all which is sound in its nomenclature should remain unaltered amid the additions which are continually being made to it. On this ground we recommend the adoption of the following rule:

§ 3. A generic name, when once established, should never be canceled in any subsequent subdivision of the group, but retained in a restricted sense for one of the constituent portions.

Generic names to be retained for the typical portion of the old genus.—When a genus is subdivided into other genera, the orignal name should be retained for that portion of it which exhibits in the greatest degree its essential characters as at first defined. Authors frequently indicate this by selecting some one species as a fixed point of reference, which they term the "type of the genus." When they omit doing so, it may still in many cases be correctly inferred that the *first* species mentioned on their list, if found accurately to agree with their definition, was regarded by them as the type. A specific name or its synonyms will also often serve to point out the particular species which by implication must be regarded as the original type of a genus. In such cases we are justified in restoring the name of the old genus to its typical signification, even when later authors have done otherwise. We submit, therefore, that

§ 4. The generic name should always be retained for that portion of the original genus which was considered typical by the author.

Example.—The genus *Picumnus* was established by Temminck, and included two groups, one with four toes, the other with three, the *former* of which was regarded by the author as typical. Swainson, however, in raising these groups at a later period to the rank of genera, gave a new name, *Asthenurus*, to the *former* group, and retained *Picumnus* for the *latter*. In this case we have no choice but to restore the name *Picumnus*, Tem., to its correct sense, canceling the name *Asthenurus*, Sw., and imposing a new name on the three-toed group which Swainson had called *Picumnus*.

When no type is indicated, then the original name is to be kept for that subsequent subdivision which first received it. Our next proposition seems to require no explanation:

§ 5. When the evidence as to the original type of a genus is not perfectly clear and indisputable, then the person who first subdivides the genus may affix the original name to any portion of it at his discretion, and no later author has a right to transfer that name to any other part of the original genus.

A later name of the same extent as an earlier to be wholly canceled.—

When an author infringes the law of priority, by giving a new name to a genus which has been properly defined and named already, the only penalty which can be attached to this act of negligence or injustice, is to expel the name so introduced from the pale of the science. It is not right, then, in such cases to restrict the meaning of the later name so that it may stand side by side with the earlier one, as has sometimes been done. For instance, the genus *Monaulus*, Vieill., 1816, is a precise equivalent to *Lophophorus*, Tem., 1813, both authors having adopted the same species as their type, and therefore when the latter genus came in course of time to be divided into two, it was incorrect to give the condemned name *Monaulus* to one of the portions. To state this succinctly:

§ 6. When two authors define and name the same genus, *both making it exactly of the same extent*, the later name should be canceled *in toto*, and not retained in a modified sense.

This rule admits of the following exception:

§ 7. Provided, however, that if these authors select their respective types from different sections of the genus, and these sections be afterward raised into genera, then both these names may be retained in a restricted sense for the new genera respectively.

Example.—The names *Œdemia* and *Melanetta* were originally co-extensive synonyms, but their respective types were taken from different sections, which are now raised into genera, distinguished by the above titles.

[No special rule is required for the cases in which the later of two generic names is so defined as to be *less extensive* in signification than the earlier, for if the later includes the type of the earlier genus, it would be canceled by the operation of section four; and if it does not include that type, it is in fact a distinct genus.]

But when the later name is more extensive than the earlier, the following rule comes into operation:

A later name equivalent to several earlier ones is to be canceled.—The same principle which is involved in section six will apply to section eight.

§ 8. If the later name be so defined as to be equal in extent to two or more previously published genera, it must be canceled *in toto*.

Example.—*Psarocolius*, Wagl., 1827, is equivalent to five or six genera published under other names, therefore *Psarocolius* should be canceled.

If these previously published genera be *separately adopted* (as is the case with the equivalents of *Psarocolius*), their original names will of course prevail; but if we follow the later author in combining them into one, the following rule is necessary:

A genus compounded of two or more previously proposed genera, whose characters are now deemed insufficient, should retain the name of one of them.—It sometimes happens that the progress of science requires two or more genera, founded on insufficient or erroneous characters, to be combined together into one. In such cases the law of priority forbids us to cancel *all* the original names and impose a *new* one on this compound genus. We must, therefore, select some one species as a type or example, and give the generic name which it formerly bore to the whole group now formed. If these original generic names differ in date, the oldest one should be the one adopted.

§ 9. In compounding a genus out of several smaller ones, the earliest of them, if otherwise unobjectionable, should be selected, and its former generic name be extended over the new genus so compounded.

Example.—The genera *Accentor* and *Prunella* of Vieillot not being considered sufficiently distinct in character, are now united under the general name of *Accentor*, that being the earliest. So also, *Cerithium*, and *Potamides*, which were long considered distinct, are now united, and the latter name merges into the former.

We now proceed to point out those few cases, which form exceptions to the law of priority, and in which it becomes both justifiable and necessary to alter the names originally imposed by authors.

A name should be changed when previously applied to another group which still retains it.—It being essential to the binomial method to indicate objects in natural history by means of *two words* only, without the aid of any further designation, it follows that a generic name should only have one meaning, in other words, that two genera should never bear the same name. For a similar reason, no two species in the same genus should bear the same name. When these cases occur, the later of the two duplicate names should be canceled, and a new term or the earliest synonym, if there be any, substituted. When it is necessary to form new words for this purpose, it is desirable to make them bear some analogy to those which they are destined to supersede, as where the genus of birds, *Plectorhynchus*, being preoccupied in ichthyology, is changed to *Plectorhampus*. It is, we conceive, the bounden duty of an author, when naming a new genus, to ascertain, by careful search, that the name which he proposes to employ has not been previously adopted in other departments of natural history. By neglecting this precaution, he is liable to have the name altered, and his authority superseded by the first subsequent author who may detect the oversight, and for this result, however unfortunate, we fear there is no remedy, though such cases would be less frequent if the detectors of these errors, would, as an act of courtesy, point them out to the author himself, if living, and leave it to him to correct his own inadvertencies. This occasional hardship appears to us to be a less evil than to permit the practice of giving the same generic name *ad libitum* to a multiplicity of genera. We submit, therefore, that

§ 10. A name should be changed which has before been proposed for some other genus in zoology or botany, or for some other species in the same genus, when still retained for such genus or species.

A name whose meaning is glaringly false may be changed.—Our next proposition has no other claim for adoption than that of being a concession to human infirmity. If such proper names of places as Covent Garden, Lincoln's Inn Fields, New Castle, Bridgewater, &c., no longer suggest the idea of gardens, fields, castles, or bridges, but refer the mind with the quickness of thought to the particular localities which they respectively designate, there seems no reason why the proper names used in natural history should not equally perform the office of correct indication, even when their etymological meaning may be wholly inapplicable to the object which they typify. But we must remember that the language of science has but a limited currency, and hence the words which compose it do not circulate with the same freedom and rapidity as those which belong to every-day life. The attention is consequently liable in scientific studies to be diverted from the contemplation of the thing signified to the etymological meaning of the sign, and hence it is necessary to provide that the latter shall not be such as to propagate actual error. Instances of this kind are indeed very rare, and in some cases, such as that of *Monodon*, *Caprimulgus*, *Paradisea apoda* and *Monoculus*, they have acquired sufficient currency no longer to cause error, and are therefore retained without change. But when we find a Batrachian reptile named in violation of its true affinities, *Mastodonsaurus*, a Mexican species termed (through erroneous information of its habitat) *Picus cafer*, or an olive colored one *Muscicapa atra*, or when a name is derived from an accidental monstrosity, as in *Picus semirostris* of Linnæus and *Helix disjuncta* of Turton, we feel justified in canceling these names, and adopting that synonym which stands next in point of date. At the same time we think it right to remark that this privilege is very liable to abuse, and ought therefore to be applied only to extreme cases and with great caution. With these limitations we may concede that

§ 11. A name may be changed when it implies a false proposition, which is likely to propagate important errors.

Names not clearly defined may be changed.—Unless a species or group is intelligibly defined when the name is given, it can not be recognized by others, and the signification of the name is consequently lost. Two things are necessary before a zoological term can acquire any authority, viz., *definition* and *publication*. Definition properly implies a distinct exposition of essential characters, and in all cases we conceive this to be indispensable, although some authors maintain that a mere enumeration of the component species, or even a single type, is sufficient to authenticate a genus. To constitute *publication*, nothing short of the insertion of the above particulars *in a printed book* can be held sufficient. Many birds, for instance, in the Paris and other continental museums, shells in the British Museum (in Dr. Leach's time), and fossils in the Scarborough and other public collections, have received MS. names, which will be of no authority until they are published. Nor can any unpublished descriptions, however exact (such as those of Forster, which are still shut up in a MS. at Berlin), claim any right of priority till published, and then only from the date of their publication. The same rule applies to cases where groups or species are published, but not defined, as in some museum catalogues, and in Lesson's 'Traitè d'Ornithologie,' where many species are enumerated by name, without any description or reference by which they can be identified. Therefore,

§ 12. A name which has never been clearly defined in some published work, should be changed for the earliest name by which the object shall have been so identified.

Specific names, when adopted as generic, must be changed.—The necessity for the following rule will be best illustrated by an example. The *Corvus pyrrhocorax*, Linn., was afterward advanced to a genus under the name of *Pyrrhocorax*. Temminck adopts this generic name, and also retains the old specific one, so that he terms the species *Pyrrhocorax Pyrrhocorax*. The inelegance of this method is so great as to demand a change of the specific name, and the species now stands as *Pyrrhocorax alpinus*, Vieill. We propose, therefore, that

§ 13. A new specific name must be given to a species when its old name has been adopted for a genus which includes that species.

N. B.—It will be seen, however, below, that we strongly object to the further continuance of this practice of elevating specific names into generic.

Latin orthography to be adhered to.—On the subject of orthography it is necessary to lay down one proposition.

§ 14. In writing zoological names, the rules of Latin orthography must be adhered to.

In Latinizing Greek words, there are certain rules of orthography known to classical scholars which must never be departed from. For instance, the names which modern authors have written *Aipunemia*, *Zenophasia*, *poiocephala*, must, according to the laws of etymology, be spelt *Æpycnemia*, *Xenophasia*, and *pœocephala*. In Latinizing modern words, the rules of classic usage do not apply, and all that we can do is to give to such terms as classical an appearance as we can, consistently with the preservation of their etymology. In the case of European words, whose orthography is fixed, it is best to retain the original form, even though it may include letters and combinations unknown in Latin. Such words for instance, as *Woodwardi*, *Knighti*, *Bullocki*, *Eschscholtzi*, would be quite unintelligible, if they were Latinized into *Vudvardi*, *Cnichti*, *Bullocci*, *Essolzi*, etc. But words of barbarous origin, having no fixed orthography, are more pliable, and hence, when adopted into the Latin, they should be rendered as classical in appearance as is consistent with the preservation of their original sound. Thus, the words *Tockus*, *awsuree*, *argoondat*, *kundoo*, etc., should, when Latinized, have been written *Toccus*, *ausure*, *argunda*, *cundu*, etc. Such words ought, in all practicable cases, to have a Latin termination given them, especially if they are used generically.

In Latinizing proper names, the simplest rule appears to be to use the termination *us*, genitive *i*, when the name ends with a consonant, as in the above examples; and *ius*, gen. *ii*, when it ends with a vowel, as *Latreille*, Latreillii, etc.

In converting Greek words into Latin, the following rules must be attended to:

Greek.		*Latin.*	*Greek.*		*Latin.*
αι	becomes	æ.	θ	becomes	th.
ει	"	i.	Φ	"	ph.
ος	terminal	us.	χ	"	ch.
ον	"	um.	Κ	"	c.
ου	becomes	u.	νχ	"	nch.
οι	"	œ.	γν	"	ng.
υ	"	y.			

When a name has been erroneously written, and its orthography has been afterward amended, we conceive that the authority of the original author should still be retained for the name, and not that of the person who makes the correction.

PART II.—RECOMMENDATIONS FOR IMPROVING THE NOMENCLATURE IN FUTURE.

The above propositions are all which, in the present state of the science, it appears practicable to invest with the character of laws.

We have endeavored to make them as few and simple as possible, in the hope that they may be the more easily comprehended and adopted by naturalists in general. We are aware that a large number of other regulations, some of which are hereafter enumerated, have been proposed and acted upon by various authors who have undertaken the difficult task of legislating on this subject; but as the enforcement of such rules would, in many cases, undermine the invaluable principle of priority, we do not feel justified in adopting them. At the same time, we fully admit that the rules in question are, for the most part, founded on just criticism, and, therefore, though we do not allow them to operate retrospectively, we are willing to retain them for future guidance. Although it is of the first importance that the principle of priority should be held paramount to all others, yet we are not blind to the desirableness of rendering our scientific language palatable to the scholar and the man of taste. Many zoological terms, which are now marked with the stamp of perpetual currency, are yet so far defective in construction, that our inability to remove them, without infringing the law of priority, may be a subject of regret. With these terms we can not interfere, if we adhere to the principles above laid down; nor is there even any remedy, if authors insist on infringing the rules of good taste, by introducing into the science words of the same inelegant or unclassical character in future. But that which can not be enforced by law, may, in some measure, be effected by persuasion; and with this view we submit the following propositions to naturalists, under the title of *recommendations for the improvement of zoological nomenclature in future.*

The best names are Latin or Greek characteristic words.—The classical languages being selected for zoology, and words being more easily remembered in proportion as they are expressive, it is self-evident that

§ *A.* The *best* zoological names are those which are derived from the the Latin or Greek, and express some distinguishing characteristic of the object to which they are applied.

Classes of Objectionable Names.—It follows from hence that the following classes of words are more or less objectionable in point of taste, though, in the case of *genera*, it is often necessary to use them, from the impossibility of finding characteristic words which have not before been employed for other genera. We will commence with those which appear the least open to objection, such as

a. Geographical names.—These words being for the most part adjectives can rarely be used for *genera.* As designations of *species* they have been so strongly objected to, that some authors (Wagler, for instance) have gone the length of substituting fresh names wherever they occur; others (*e. g.* Swainson), will only tolerate them when they apply *exclusively*, as *Lepus hibernicus*, *Troglodytes europæus*, etc. We are by no means disposed to go to this length. It is not the less true that the *Hirundo javanica* is a *Javanese* bird, even though it may occur in other countries also, and though other species of *Hirundo* may occur in Java. The utmost that can be urged against such words is, that they do not tell the *whole truth*. However, as so many authors object to this class of names, it is better to avoid giving them, except when there is reason to believe that the species is chiefly confined to the country whose name it bears.

b. Barbarous names.—Some authors protest strongly against the introduction of exotic words into our Latin nomenclature; others defend the practice with equal warmth. We may remark, first, that the practice is not contrary to classical usage, for the Greeks and Romans did occasionally, though with reluctance, introduce barbarous words in a modified form into their respective languages. Secondly, the preservation of the trivial names which animals bear in their native countries is often of great use to the traveler in aiding him to discover and identify species. We do not, therefore, consider, if such words have a Latin termination given to them, that the occasional and judicious use of them as scientific terms can be justly objected to.

c. Technical names.—All words expressive of trades and professions have been by some writers excluded from zoology, but without sufficient reason. Words of this class, *when carefully chosen*, often express the peculiar characters and habits of animals in a metaphorical manner, which is highly elegant. We may cite the generic terms *Arricola*, *Lanius*, *Pastor*, *Tyrannus*, *Regulus*, *Mimus*, *Ploceus*, etc., as favorable examples of this class of names.

d. Mythological or historical names.—When these have no perceptible reference or allusion to the characters of the object on which they are conferred, they may be properly regarded as unmeaning and in bad taste. Thus, the generic names *Lesbia*, *Leilus*, *Remus*, *Corydon*, *Pasiphæ*, have been applied to a humming-bird, a butterfly, a *beetle*, a parrot, and a crab, respectively, without any perceptible association of ideas. But mythological names may sometimes be used as generic, with the same propriety as technical ones, in cases where a direct allusion can be traced between the narrated actions of a personage and the observed habits or structure of an animal. Thus, when the name *Progne* is given to a swallow, *Clotho* to a spider, *Hydra* to a polyp, *Athene* to an owl, *Nestor* to a grey-headed parrot, etc., a pleasing and beneficial connexion is established between classical literature and physical science.

e. Comparative names.—The objections which have been raised to words of this class are not without foundation. The names, no less than the definitions of objects, should, where practicable, be drawn from positive and self-evident characters, and not from a comparison with other objects, which may be less known to the reader than the one before him. Specific names, expressive of comparative size, are also to be avoided, as they may be rendered inaccurate by the after discovery of additional species. The names *Picoides*, *Emberizoides*, *Pseudoluscinia*, *rubeculoides*, *maximus*, *minor*, *minimus*, etc., are examples of this objectionable practice.

f. Generic names compounded from other genera.—These are in some degree open to the same imputation as comparative words; but as they often serve to express the position of a genus as intermediate to, or allied with, two other genera, they may occasionally be used with advantage. Care must be taken not to adopt such compound words as are of too great length, and not to corrupt them in trying to render them shorter. The names *Galloparo*, *Tetraogallus*, *Gypaetos*, are examples of the appropriate use of compound words.

g. Specific names derived from persons.—So long as these complimentary designations are used with moderation, and are restricted to persons of eminence as scientific zoologists, they may be employed with propriety in cases where expressive or characteristic words are not to be found. But we fully concur with those who censure the practice of naming species after persons of no scientific reputations, as curiosity dealers (e. g. *Caniveti Boissoneauti*), Peruvian priestesses (*Cora amazilia*), or Hottentots (*Klassi*).

h. Generic names derived from persons.—Words of this class have been very extensively used in botany, and therefore it would have been well to have excluded them wholly from zoology, for the sake of obtaining a *memoria technica* by which the name of a genus would at once tell us to which of the kingdoms of nature it belonged. Some few personal generic names have, however, crept into zoology, as *Cuvieria*, *Mulleria*, *Rossia*, *Lessonia*, etc., but they are very rare in comparison with those of botany, and it is, perhaps, desirable not to add to their number.

i. Names of harsh and inelegant pronunciation.—These words are grating to the ear, either from inelegance of form, as *Huhua*, *Yuhina*, *Craxirex*, *Esch-Scholtzi*; or, from too great length, as *chirostrongylostinus*, *Opetiorhynchus*, *brachypodiodes*, *thecodontosaurus*, not to mention the *Enaliolimnosaurus crocodilocephaloides* of a German naturalist. It is needless to enlarge on the advantage of consulting euphony in the construction of our language. As a general rule it may be recommended to avoid introducing words of more than five syllables.

k. Ancient names of animals applied in a wrong sense.—It has been customary, in numerous cases, to apply the names of animals found in classic authors at random to exotic genera or species which were wholly unknown to the ancients. The names of *Cebus*, *Callithrix*, *Spiza*, *Kitta*, *Struthus*, are examples. This practice ought by no means to be encouraged. The usual defense for it is, that it is impossible now to identify the species to which the name was anciently applied. But it is certain that if any traveler will take the trouble to collect the vernacular names used by the modern Greeks and Italians for the vertebrata and mollusca of Southern Europe, the meaning of the ancient names may, in most cases, be determined with the greatest precision. It has been well remarked that a Cretan fisher-boy is a far better commentator on Aristides' "History of Animals," than a British or German scholar. The use, however, of ancient names, *when correctly applied*, is most desirable, for, "in framing scientific terms, the appropriation of old words is preferable to the formation of new ones."

l. Adjective generic names.—The names of genera are, in all cases, essentially substantive, and hence adjective terms can not be employed for them without doing violence to grammar. The generic names of *Hians*, *criniger*, *cursorius*, *nitidula*, etc., are examples of this incorrect usage.

m. Hybrid names.—Compound words, whose component parts are taken from two different languages, are great deformities in nomenclature, and naturalists should be especially guarded not to introduce any more such terms into zoology, which furnishes too many examples of them already. We have them compounded of Greek and Latin, as *Dendrofalco*, *Gymnocorous*, *Monoculus*, *Arborophila*, *flavigaster*; Greek and French, as *Jacamaralcyon*, *Jacamerops*; and Greek and English, as *Bullockoides*, *Gilbertsocrinites*.

n. Names closely resembling other names already used.—By rule 10, it was laid down, that when a name is introduced which is *identical* with one previously used, the later one should be changed. Some authors have extended the same principle to cases where the latter name, when correctly written, only approaches in form, without wholly coinciding with the earlier. We do not, however, think it advisable to make this law imperative, first, because of the vast extent of our nomenclature, which renders it highly difficult to find a name which shall not bear more or less resemblance in sound to some other; and, secondly, because of the impossibility of fixing a limit to the degree of approximation beyond which such a law should cease to operate. We content ourselves, therefore, with putting forth this proposition merely as a recommendation to naturalists, in selecting generic names, to avoid such as too closely approximate words already adopted. So with respect to species, the judicious naturalist will aim at variety of designation, and will not, for example, call a species *virens*, or *virescens*, in a genus which already possesses a *viridis*.

o. Corrupted words.—In the construction of compound Latin words, there are certain grammatical rules which have been known, and acted on for two thousand years, and which a naturalist is bound to acquaint himself with, before he tries his skill in coining zoological terms. One of the chief of these rules is, that in compounding words, all the radical or essential parts of the constituent members must be retained, and no change made except in the variable terminations. But several generic names have been lately introduced which run counter to this rule, and form most unsightly objects to all who are conversant with the spirit of the Latin language. A name made up of the first half of one word, and the last half of another, is as deformed a monster in nomenclature as a mermaid or a centaur would be in zoology; yet we find examples in the names *Corcorax* (from *Corvus* and *Pyrrhocorax*), *Cypsnagra* (from *Cypselus* and *Tanagra*), *Merulaxis* (*Merula* and *Lynallaxis*), *Loxigilla* (*Loxia* and *Fringilla*), etc. In other cases, when the *commencement* of both the simple words is retained in the compound, a fault is still committed by cutting off too much of the radical and vital portions, as is the case in *Bucorvus* (from *Buceros* and *Corvus*), *Ninox* (*Nisus* and *Noctua*), etc.

p. Nonsense names.—Some authors having found difficulty in selecting generic names which have not been used before, have adopted the plan of coining words at random, without any derivation or meaning whatever. The following are examples: *Viralva*, *Xema*, *Azeca*, *Assiminia*, *Quedius*, *Spisula*. To the same class we may refer *anagrams* of other generic names, as *Dacelo* and *Cedola* of *Alcedo*, *Zapornia* of *Dorzana*, etc. Such verbal trifling as this is in very bad taste, and is especially calculated to bring the science into contempt. It finds no precedent in the Augustan age of Latin, but can be compared only to the puerile quibblings of the Middle Ages. It is contrary to the genius of all languages, which appear never to produce new words by spontaneous generation, but always to derive them from some other source, however distant or obscure. And it is peculiarly annoying to the etymologist, who, after seeking in vain through the vast store-house of human language for the parentage of such words, discovers at last that he has been pursuing an *ignis fatuus*.

q. Names previously canceled by the operation of § 6.—Some authors consider that when a name has been reduced to a synonym by the operations of the laws of priority, they are then at liberty to apply it at pleasure to any new group which may be in want of a name. We consider, however, that when a word has once been proposed in a given sense, and has afterward sunk into a synonym, it is far better to lay it aside forever, than to run the risk of making confusion by reissuing it with a new meaning attached.

r. Specific names raised into generic.—It has sometimes been the practice in subdividing an old genus, to give to the lesser genera so formed the names of their respective typical species. Our rule 13 authorizes the forming of a new specific name in such cases, but we further wish to state our objections to the practice altogether, considering, as we do, that the original specific names should, as far as possible, be held sacred, both on the grounds of justice to the authors and of practical convenience to naturalists. We would strongly dissuade from the *further continuance* of a practice which is gratuitous in itself, and which involves the necessity of altering long established specific names.

We have now pointed out the principal rocks and shoals which lie in the path of the nomenclator, and it will be seen that the navigation through them is by no means easy. The task of constructing a language which shall supply the demands of scientfic accuracy on the one hand, and of literary elegance on the other, is not to be inconsiderately undertaken by unqualified persons. Our nomenclature presents but too many flaws and inelegancies already, and as the stern law of priority forbids their removal, it follows that they must remain as monuments of the bad taste or bad scholarship of their authors to the latest ages in which zoology shall be studied.

Families to end in idæ and Subfamilies in inæ.—The practice suggested in the following proposition has been adopted by many recent authors, and its simplicity and convenience is so great that we strongly recommend its universal use.

§ *B.* It is recommended that the assemblages of genera, termed *families*, should be uniformly named, by adding the termination *idæ* to the name of the earliest known, or most typically characterized genus in them; and that their subdivisions, termed *subfamilies*, should be similarly constructed, with the termination *inæ*. These words are formed by changing the last syllable of the genitive case into *idæ* or *inæ*, as *strix, Strigis, Strigidæ, Buceros, Bucerotis, Bucerotidæ*, not *Strixidæ, Buceridæ*.

Specific names to be written with a small initial.—A convenient *memoria technica* may be effected by adopting our next proposition. It has been usual, when the titles of species are derived from proper names, to write them with a capital letter, and, hence, when the specific name is used alone, it is liable to be occasionally mistaken for the title of a genus. But if the title of *species* were *invariably* written with a *small* initial, and those of *genera* with a *capital*, the eye would at once distinguish the rank of the group referred to, and a possible source of error would be avoided. It should be further remembered that all species are *equal*, and should therefore be written all *alike*. We suggest, then, that

§ *C.* Specific names should *always* be written with a small initial letter, even when derived from persons or places, and generic names should be always written with a capital.

The authority for a species, exclusive of the genus, to be followed by a distinctive expression.—The systematic names of zoology being still far from that state of fixity which is the ultimate aim of the science, it is frequently necessary, for correct indication, to append to them the name of the person on whose authority they have been proposed. When the same person is authority both for the specific and generic name, the case is very simple, but when the specific name of one author is annexed to the generic name of another, some difficulty occurs. For example, the *Muscicapa crinita* of Linnæus belongs to the modern genus *Tyrannus* of Vieillot; but Swainson was the first to apply the specific name of Linnæus to the generic one of Vieillot. The question now arises, whose authority is to be quoted for the name *Tyrannus crinitus?* The expression *Tyrannus crinitus*, Lin., would imply what is untrue, for Linnæus did not use the term *Tyrannus*, and *Tyrannus crinitus*, Vieil., is equally incorrect, for Vieillot did not adopt the name *crinitus*. If we call it *Tyrannus crinitus*, Sw., it would imply that Swainson was the first to describe the species, and Linnæus would be robbed of his due credit. If we term it *Tyrannus*, Vieil, *crinitus*, Lin., we use a form which, though expressing the facts correctly, and therefore not without advantage in particular cases, when great exactness is required, is yet too lengthy and inconvenient to be used with ease and rapidity. Of the three persons concerned with the construction of a binomial title in the case before us, we conceive that the author who *first* describes and names a species which forms the groundwork of later generalizations, possesses a higher claim to have his name recorded than he who afterward defines a genus which is found to embrace that species, or who may be the mere accidental means of bringing the generic and specific names into contact. By giving the authority for the *specific* name in preference to all others, the inquirer is referred *directly* to the original description, habitat, etc., of the species, and is at the same time reminded of the date of its discovery, while genera being less numerous than species, may be carried in the memory or referred to in systematic works, without the necessity of perpetually quoting their authorities. The most simple mode, then, for ordinary use, seems to be, to appeal to the original authority for the species, when not applying to the genus also some distinctive mark, such as (sp.), implying an exclusive reference to the *specific* name, as *Tyrannus crinitus*, Lin. (sp.), and to omit this expression when the same authority attaches to both genus and species, as *Ostrea edulis*, Lin. Therefore,

§ *D.* It is recommended that the authority for a specific name, *when not applying to the generic name*, also should be followed by the distinctive expression (sp.)

New genera and species to be defined amply *and* publicly.—A large proportion of the complicated mass of synonyms which has now become the opprobrium of zoology, has originated either from the slovenly and imperfect manner in which species and groups have been originally defined, or from their definitions having been inserted in obscure local publications which have never obtained an extensive circulation. Therefore, although under § 12 we have conceded that mere insertion in a printed book is sufficient for *publication*, yet we would strongly advise the authors of new groups always to give in the first instance a full and accurate definition of their characters, and to insert the same in such periodical or other works as are likely to obtain an immediate and extensive circulation. To state this briefly,

§ *E.* It is recommended that new genera or species be amply defined, and extensively circulated in the first instance.

The names to be given to subdivisions of genera to agree in gender with the original genus.—In order to preserve specific names as far as possible in an unaltered form, whatever may be the changes which the genera to which they are referred may undergo, it is desirable, when it can be done with propriety, to make the new subdivisions of genera agree *in gender* with the old groups from which they are formed. This recommendation does not, however, authorize the changing the gender or termination of a genus already established. In brief,

§ *F.* It is recommended that in subdividing an old genus in future, the names given to the subdivisions should agree in gender with that of the original group.

Etymologies and types of new genera to be stated.—It is obvious that the names of genera would, in general, be far more carefully constructed, and their definitions would be rendered more exact, if authors would adopt the following suggestion:

§ *G.* It is recommended that in defining new genera, the etymology of the name should be always stated, and that one species should be invariably selected as a type or standard of reference.

Observations upon Stenopora fibrosa and the genus Chetetes.

No class of fossils found within the Cincinnati Group has been regarded by collectors with the same degree of uncertainty, as the corals. No one scarcely has relied upon the name by which any coral found at the Cincinnati quarries was known, save, perhaps, two or three species. And, as the sequel will show, this uncertainty, strange as it may seem, has not been without foundation. The most common coral, yea, the most common fossil in the group, has hitherto borne the name of a genus that has never been found within it, and likewise worn an erroneous specific name. And, yet, this same coral was the second fossil collected and described from this locality. The *Isotelus gigas* was published by DeKay in 1824, and the *Calamopora fibrosa* by Goldfuss, in 1826.

After the most careful examination of hundreds of specimens, polished and unpolished, fractured and weather-worn, under the most favorable circumstances, the fact that no coral possessing the generic characters of *Chetetes* was ever found within the Cincinnati Group seems too clearly established to leave a remnant of doubt upon the subject. And that the corals which have been generally known under the generic name of *Chetetes* belong to the genus *Stenopora* seems quite clear.

The genus *Chetetes* was founded by Fisher in 1837, upon the type species *C. radians*, obtained from the carboniferous rocks of Russia. It is an essential generic characteristic that the walls of the tubes are inseparably connected together, owing to the fissiperous method of reproduction. Now, the walls of the tubes of the corals from the Cincinnati Group readily separate, and the evidences are incontestible that the method of reproduction was exclusively gemmiparous.

For this reason, the *Chetetes petropolitanus*, found in the Lower Silurian rocks of Russia, in which Lonsdale discovered the divisional laminæ of one tube developed within the area of one which preëxisted, does not exist in this locality.

For the purpose, however, of more clearly establishing this fact in the mind of the reader, the generic characters of *Stenopora* and *Chetetes*, as well as the specific characters of *fibrosa* and *petropolitanus*, are here reproduced, with the remarks of Lonsdale upon the generic characters of *Chetetes*.

Genus *Stenopora*—(Lonsdale).

Polypodom polymorphous, composed of round or polygonal tubes, radiating from an imaginary axis to the surface, where the bounding ridges are tuberculated; young tubes interpolated by lateral budding between the old; tubes constricted at irregular distances in planes parallel with the surface, and partially closed at the orifice by a concave diaphragm, perforated in the center; no connecting tubuli nor foramina.

In some species the tubes are polygonal throughout, in others they are polygonal in the middle where closely packed, and round near the surface where further apart. The interior of the tubes exhibits only imperfect diaphragms, perforated in the middle.

Stenopora fibrosa—(GOLDFUSS, 1826).

Corallum polymorphous, usually forming cylindrical branches composed of polygonal tubes (usually six in the space of one line), slightly and irregularly flexuous, nearly straight in the middle, abruptly bending outward to the surface, near the sides; edges and sides smooth, or marked in parts with strong, close irregularities of growth, forming tubercles on the angular edges and wrinkles across the sides; young, interpolated tubes rapidly reaching their full diameter; substance of the tubes thick, the interior cylindrical, traversed by numerous diaphragms, at irregular distances, usually the width of the tubes apart, sometimes in places irregularly crowded; surface having a net-work of polygonal ridges, with an inner concave space, in which is the small round aperture.

This species was founded by Goldfuss, in 1826 (Petrefacta, pp. 82, 215, tab. xxviii, figs. 3 and 4; tab. xxiv. fig. 9), upon specimens obtained from Lexington, Kentucky. The branching forms of this species are the most common and abundant corals found about the Cincinnati quarries.

Stenopora lycoperdon—(SAY).

Corallum massive, hemispherical or subhemispherical, growing from a flat, expanded, round or somewhat oval, membraneous, concentrically wrinkled base. Tubes minute, fiber-like, traversed by diaphragms, and in all other respects corresponding with *Stenopora fibrosa*. The size, form, and concentrically wrinkled base are the only characters by which these two species can be distinguished, if indeed one is not merely a variety of the other.

Prof. Hall, in the description of this species under the name of *Chetetes lycoperdon*, in the first vol. of the Paleontology of New York, says, that the "coral increases by subdivisions of the parent tube, or by the successive addition of lateral or marginal tubes." It is quite true that it does increase in one of these ways, and it is equally true that it does not in the other. In other words, it does increase by lateral tubes, either interpolated or marginal, but it does not increase by subdivisions of the parent tube. Its method of growth was simply gemmiparous, and therefore it belongs to the genus *Stenopora*, and not to *Chetetes*.

It includes all the massive forms found at the Cincinnati quarries, some of which weigh five pounds or more, and is regarded by McCoy as merely a variety of *Stenopora fibrosa*.

All the numerous forms of branching and massive corals found at Cincinnati, which are composed of masses of aggregated tubes, crossed by diaphragms, belong to these two species.

The following remarks concerning the genus *Chetetes*, by W. Lonsdale, are taken from his work on the paleozoic corals of Russia, as published in vol. 1, p. 593, of "Russia and the Ural Mountains."

Chetetes—(FISCHER).

So greatly do the corals referable to this genus resemble *Favosites* (*Calamopora*) that all the authorities, except M. Fischer, by whom paleozoic species have been described, have considered them as belonging to it. M. Fischer, in his summary of characters, observes, that *Chætetes* is distinguished from *Favosites* (*Calamopora*) by the absence in the tubes of "diaphragms" or transverse laminæ. This statement probably originated from an examination of specimens of *Chetetes radians*, in which species the diaphragms are often very widely separated, and not unfrequently have been almost altogether removed by decomposition. In this respect, therefore, *Chetetes* does not differ from *Favosites*; but it differs in the absence of connecting foramina as well as in other essential structural characters.

When a specimen of *Favosites*, retaining in part the substance of the original coral, is vertically fractured, the walls of the adjacent columns separate readily, and the exposed surfaces are clearly shown to present the outer side, by exhibiting the irregular lines of growth, and by the total absence of any attached fractured edges of diaphragms. At the re-entering angles, formed by the meeting of the planes of two adjacent columns, there may likewise be generally traced an undisturbed line of separation. In those cases in which mineral matter has wholly replaced the original substance of the coral, and has also been moulded on its structural markings, the same tendency to divide along the outer side of the walls is retained, the exposed surfaces equally exhibiting the irregular lines of growth, and the absence of fractured diaphragms. Care, however, must be taken in those species which, like *Favosites alveolaris*, have the connecting foramina on the angles, to detect the line of separation along that junction, as the structural inequalities are there often great, and the dividing seams in consequence concealed. In some cases, also, an apparently perfect blending is produced by a projecting foramen, being received within a corresponding opposite cavity. In all these instances, nevertheless, the exterior sides of the broad planes of the columns are easily parted, and their true nature may be clearly recognized.

On the contrary, in *Chetetes*, the walls of adjacent columns seem to be inseparable, or formed of intimately united laminæ. In extensive sections of *Chetetes radians*, having the interior of the tubes but slightly coated with infiltered matter, not a single instance was discovered of the outer side of a wall. Many flat, vertical planes were noticed as well as re-entering angles formed by the junction of two walls, situated obliquely to the general surface of the specimen; but in every case the flat plane, or the re-entering angle, could be traced upward or downward, till it passed within the area of a tube, and therefore ascertained to be an inner portion of the same tube exposed by fracture; or, if this could not be effected, a careful examination of the edges of the planes never failed to prove that they were rough, and that the unevenness was due to the remains of walls which had projected from them, and had constituted inner sides of destroyed columns. In other specimens of the same species retaining the original substance of the coral, but having the tubes filled with calcareous spar, not a vestige of the outer surface of a wall could be discovered, and in others again, in which the animal structure had been replaced by infiltered matter, characters analogous to those of *Favosites* could in no wise be perceived.

These differences are believed to be necessary results of the distinct mode by which additional columns were developed in each genus.

In *Favosites*, the additional tubes dependent on the growth of the polypes originated, so far as the author is acquainted with the genus, either in gemmules, deposited in interspaces, or developed on the extreme margin of the parent polype. In either instance, a perfect individuality immediately took place, and the young animal, which rapidly attained considerable lateral dimensions, constructed its tube without the area of the parent column, building up the walls unassisted by its neighbors. In almost every example, the sides of the surrounding tubes are impressed by those of the interposed tube, indicating that the whole grew contemporaneously, and that the struggles for space of the vigorous, rapidly expanding young polype, interfered with the outline of the walls of the full-grown animal, which necessarily possessed, on account of its lateral enlargement having ceased, no power to resist such encroachments. From the mode of development having been thus wholly interstitial, it is inferred that the exterior surfaces of adjacent walls must naturally and easily separate. It is further inferred, that the polypes, at the superior boundary of the coral mass, had no common connection, but were perfectly circumscribed and separated.

The essential manner of developing additional tubes in *Chetetes* was, however, by a subdivision within the area of the parent. On examining transverse sections, particularly those in which the coral is but slightly coated with infiltered matter, a plate will be frequently seen projecting from one or more sides, and by extending the research, similar laminæ will be found to range quite across, effecting either a simple subdivision into two areas, or a complex one into three or even four. These intersected spaces are easily distinguished by the plates springing from sides, and not angles. Again, in a vertical section of such specimens, thin interrupted laminæ will be readily detected, ranging perpendicularly within many of the tubes. They are not usually continuous for any distance, but they perfectly agree in their nature with the plates just noticed, and the want of persistence may be rightly assigned to the perishable tendency of the coral. Cases, however, were observed of plates which extended without interruption, and probably from their first development for more than an inch. In such examples, the walls of the original tube ranged regularly upward, but with a slight divergence, and the introduced laminæ, at first not quite medial, gradually assumed that position. From this plan of producing additional tubes, it is presumed that there could be no natural tendency in the component structure of the walls to divide into two plates, as in *Favosites*; and, further, that the polypes, by which a mass of tubes was formed, had a community of existence, and were united at the outer boundary of the coral in one animal layer.

Based on these imperfectly explained structures, the following provisional generic characters are proposed:

A polymorphous polypidom, formed of tubes, closely aggregated and transversed by diaphragms; walls inseparable; additional tubes produced by subdivisions, within the area of the parent tube, or by extensions of the polype along the margin of the coral mass.

To suggest grounds for specific distinctions in fossil corals, of so simple a composition, is extremely difficult, especially when characters dependent upon the limits of growth have not been ascertained. So far, however, as the describer's observations have extended, the distinctions in the arrangement of the diaphragms afford, apparently, one means for inferring differential structures; those variations implying it is presumed, peculiarities in the form of the polypes. In the remarks upon *Chetetes radians*, it is shown that the diaphragms are distributed in concentric or parallel bands, and often at considerable distances the bands being composed of a single series of plates, or of a variable number of closely situated laminæ, whilst in the account of *Chetetes petropolitanus* it is explained that the diaphragms are irregularly distributed over the whole area of a vertical section. In other fossils belonging to the genus, but not included in this notice, distinct peculiarities were observed. It is further suggested that the characters exhibited by well preserved, terminal edges of the tubes might afford some aid in specific determinations; a protected surface of *Chetetes radians*, which presented probably a periodical renewal of growth, having the edges surmounted by a series of very prominent tubercles.

The above remarks are not offered with the idea that the characters alluded to could constitute alone specific distinctions, but they are advanced with a hope that they may assist in discovering essential structures.

Chetetes petropolitanus.

Globular, hemispherical, or inversely conical; tubes polygonal; irregularly arranged; diaphragms not in bands, but unequally distributed throughout the tubes.

Favosites petropolitanus (Pander, 1830).

Calamopora fibrosa (Eichwald, 1840).

A careful examination of specimens, agreeing with M. Pander's figures, and general remarks, led to the inference that they possessed all the essential generic characters of *Chetetes.*

M. Pander considers the globular, hemispherical, and conical specimens described by him as varieties of one species, and it is believed that the differences which may be noticed internally depend on the conditions under which the polypidom was developed. In a well preserved hemispherical specimen, two inches in diameter, and 9 lines in the thickest part, the tubes did not radiate suddenly from the center, but the lateral increase had been produced by the successive addition of marginal tubes, which sprung from the base and slightly inclined outward.

The concave under-surface of the same specimen exhibited, besides concentric irregularities, the oblique lower terminations of the tubes, arranged in a manner which resembled radiating lines. In a conical specimen, $1\frac{1}{4}$ inches in height, and an inch in diameter at the upper (broad) extremity, the increase in width had also resulted from a similar mode of production; but all the tubes necessarily ranged vertically, and the conical surface exhibited also circular irregularities, as well as terminations of the tubes, though less distinctly in that specimen than in another of the same form. A mass of a nearly globular shape, $2\frac{1}{2}$ inches in one diameter, and 3 in the other, had the surface almost wholly weathered, and therefore exhibited no clear characters; but, internally, the arrangement of the tubes agreed with that of the hemispherical specimen.

The original walls of the coral were apparently almost membranous, and liable, under some conditions, to irregular contractions, as well as considerable deviations in the line of growth; but in the large globular mass such inequalities were far less conspicuous.

The diaphragms, exposed in vertical sections, of all varieties of form, were distributed over the whole surface, and without the least indication of grouping in bands. In the hemispherical and conical specimens, which exhibited considerable irregularities in growth, the disposition of the diaphragms was very unequal; while in the large globular mass, the plates, without observing any definite order, were uniformly distributed. In some portions, however, of the other varieties the number of plates corresponded; and the differences displayed, may, it is believed, be rightly assigned to circumstances which affected the mode of growth or production of the polypes, and consequently modified the distribution of the diaphragms.

With respect to the development of additional tubes within the area of those which pre-existed, it may be stated that divisional laminæ were noticed in transparent, vertical slices of the hemispherical and globose varieties, though less distinctly in the latter than the former; and that while in a similar section of the conical specimen they were not satisfactorily detected, a transverse slice exhibited clearly divisional laminæ, ranging from opposite planes. The whole of these specimens, moreover, proved clearly the powers which the polype mass possessed of extending laterally and producing marginal tubes.

Chetetes petropolitanus having been considered identical with *Favosites (Chetetes) fibrosa var. globosa* of the Eifel, it is necessary to observe, that in vertical sections of a specimen of the latter fossil, which belonged to M. de Verneuil's cabinet, perpendicular divisional laminæ within the tubes were noticed, also fragments of the original coral, exhibiting only interior surface walls, similar to those of *Chetetes radians*; and it was therefore inferred that the fossil ought to be removed from the genus *Favosites*. As regards the species, it may be stated that the diaphragms were uniformly rare, without any signs of disturbed growth. The height of the specimen was 7 lines.

Ancient Relics found in Cincinnati.

The point of the hill east of the old Brighton House, in the city of Cincinnati, called Riddle's hill, has long been known as an Indian burying ground, but was never explored, until within the past thirty days.

On the 28th of August, Dr. H. H. Hill and G. W. Vallandingham opened two graves, one of which proved to be a double grave. In the single one they found a few broken bone awls, bear's tusks, flint chips, human teeth in good condition, human bones badly decayed, and some small flakes of mica. In the double grave they found one flint knife, four flint arrow heads, several bear's tusks, the lower end of each of which had been cut off diagonally, so as to form a sharp edge on the exterior, or side of greatest curvature; two wolf's teeth, with the bone ground off of the lower portion; four beads, two made of bone, and the others of the teeth of some animal; a fragment of a sandstone pipe, some small pieces of mica, human teeth, and badly decayed bones.

On the 31st of August, Dr. Hill resumed work in the same graves, and found two points of deer's horns, a bone awl, some flint chips, animal teeth, and more human teeth, and decayed bones. In the afternoon he opened another grave, two rods east of the first, and found the bones of two adults and one child, so much decayed that the sex could not be ascertained; one flat, siliceous, black-banded slate gorget, with two holes in the central part, drilled from both sides; half of a gray, siliceous, banded slate gorget, preserving, three holes (it probably contained six); half of a brown, siliceous, banded slate gorget, preserving one hole (it probably had contained two); one limestone gorget, having six holes, broken in three pieces, and much changed by chemical action since its burial; some bear's tusks, cut off in the same manner as the others, small scales of mica, and one stone hatchet, usually called a bark peeler, or skin dresser.

On the 5th of September, Dr. Hill again resumed work in the first diggings, and found two arrow heads, a number of bear's teeth, beads, broken bone awls, and scales of mica, two fragments of a large shell

(*Pyrula*), and a large *Pyrula* lying by the side of a skull, which was so badly decayed that it could not be preserved. The *Pyrula* had the center cut out, changing it into a dipper, a very useful article to the original possessor, and now highly prized by its owner, though slightly broken at the large end. All teeth found were well preserved.

On the 7th of September, the work was again resumed by Dr. Hill, accompanied by R. B. Moore, Esq. They found a piece of a large shell, carved on the inside, but the figure can not be determined, because part of it has been broken away; one siliceous, banded slate gorget with two holes, drilled from both sides; three limestone gorgets, almost destroyed by time and chemical action; a few bear's tusks, beads and awls, and some large pieces of mica.

On the 11th of September, the work was resumed by Dr. Hill, Mr. Moore, Mr. Vallandingham, and a laborer. They found a great many bear's teeth, arrow heads, bone beads, bone awls; two copper awls about one and a half inches in length, with handles made of the points of deer's horns; scales of mica, human teeth, and decayed bones.

On the 19th of September, Dr. Hill resumed the work, and found two bear's tusks, three wolf's teeth, two arrow heads, and portions of the lower jaw of some small animal. Again, on the 20th of September, Dr. Hill found two small bone awls, one large arrow head, and some flint chips, part of a deer's horn, a lot of polishing stones, and two small hand hammers.

The bones in some of the graves were much more decayed, and more nearly obliterated than in others, though none of the human bones were found in a condition suitable for preservation. The partially destroyed limestone gorgets speak, too, of the high antiquity of these burials. None of the interments could have been made three feet deep, and probably not much over two feet, or the depth at which the remains are at present found.

We have evidently here the cemetery of a tribe of Indians who buried the body and personal effects of the deceased in the same grave; or, if not the whole of the personal effects, yet a representation of them. It may be inferred from these relics that the possessors lived by hunting with the bow and arrow, and dressed in the skins of animals. The clothing, and bows and arrows have disappeared, but the arrow heads, flint chips with which the bows and arrows were scraped, stone implements used in dressing the hides, and polishing stones with which they were made, and the bone and copper awls used in making the habiliments, remain in almost as good condition as when in use. Beads, made of the teeth of wolves, were worn either as adornments or trophies of the chase. The bear's tusks, not having been perforated to be worn, and every one having been ground to a sharp edge at the base, on one side, were used for some purpose unknown. The so-called "gorgets," too, which consist of thin, flat, rectangular stones, from four to eight inches in length, an inch to an inch and a half in width, and an eighth to a quarter of an inch in thickness, having two or more perforations in the central part, were used for some purpose not fully understood. They have generally been supposed to have been ornaments or badges of distinction, and are hence called "gorgets," but this use has not, by any means, been definitely ascertained. Some idea of ornament seems to be manifested in the carving on the shell, and it is to be regretted that no more of it is preserved. These people must have acquired some idea of the size of the continent, however vague, for no doubt can be entertained that the copper awls came from the Lake Superior region, and the *Pyrulas* from the Gulf of Mexico.

REVIEWS, BOOK NOTICES, ETC.

THE JOURNAL.—This number completes the first volume of the "Cincinnati Quarterly Journal of Science," and we take this opportunity to express our obligations for the favorable notices, and criticisms, it has received from the *National Normal*, *American Journal of Science and Arts*, and all the Cincinnati daily papers, *Times*, *Enquirer*, *Gazette*, *Commercial*, *Star*, *Volksblatt and Volksfreund.*

The work must speak for itself, and, therefore, no further review will be made, than to mention the fact, that twenty-five new species, belonging to the fossil remains, of the Cincinnati Group have been named, figured and defined, and that three genera, before unknown, have been added to the column of animal life during the year, without mentioning other published matter. But little, however, of the great store-house of animal remains of the Silurian age has yet been explored, and no department has been exhausted. Relics of ocean life, unproclaimed and undiscovered, doubtless exist in the bosom of every hill, and lie scattered on the exposed banks of surplus earth from every quarry, awaiting the services of the pick and shovel, or the hand of the collector to make them known to the paleontologist for definition and classification. If the Journal is published the ensuing year, it is not difficult to foresee from whence as many new species will be derived for description and publication as have been defined and illustrated during the present year.

Cooley's Physical Science Series.—These books upon Natural Philosophy and Chemistry, for graded schools and academic classes, are intended to fill the mind of the student with practical information, and to discipline it in modes of thought and observation. The matter has been judiciously selected and thoroughly systematized. Technical words are fully and clearly defined, and to this is added an illustration or the description of an easy experiment, for the purpose of bringing the meaning of the words and purport of the text to the comprehension of the merest child. The plan of the work is so pleasing, and the arrangement so plain and instructive, that an industrious child might master the philosophy and the science without the aid of an instructor. An intelligent teacher, however, could not fail with these books to impress the entire matter upon the minds of each and every one, if he or she simply performed the experiments in the presence of the class. If the author intended to make Physical Science easy, and to place the knowledge of it within the reach of every child in the country, he has most successfully accomplished his work. Scribner, Armstrong & Co., publishers, 654 Broadway, New York. C. B. Ruggles, Agent for Ohio, Kentucky, and Tennessee, care Geo. E. Stevens & Co., Cincinnati, Ohio.

Elements of Natural Philosophy, by S. A. Norton.—This work, by an experienced teacher of the science of Physics, is methodically arranged and thoroughly illustrated. The definitions are full, clear, and precise. The student is first introduced to a full and comprehensive statement of the properties of matter; this is followed by the philosophy of the mechanics of solids and fluids, undulations, acoustics, optics, effects, distribution and sources of heat and electricity, etc. Nothing seems to have been omitted from any department of the science that would tend to make the work available as a text-book, nor has anything been included that is not in its proper place. The copious illustrations and accurate statements lead the pupil at once to correct ideas of the phenomena of nature, without the constant aid of a teacher. All obstacles are removed from the road to a knowledge of the subjects treated, and on every hand are provided the most pleasant and instructive retreats for thought and observation. The work will be found in the unparalleled series of school books published by Wilson, Hinkle & Co., Cincinnati, Ohio.

Resources of Tennessee.—Mr. J. B. Killebrew, Secretary of the Bureau of Agriculture of Tennessee, assisted by Messrs. J. M. Safford, C. W. Charlton, and Bentley, has prepared and published a work of about 1,200 pages, on the "Resources of Tennessee." It treats of the geology, mineralogy, climate, soils, products, population, and wealth of the State. Almost every industrial pursuit has received attention, and such statistics and information as might be expected to be serviceable to persons desiring to emigrate to that State have been carefully collected together. The entire area of the State is about 42,000 square miles, or 26,880,000 acres, which is divided into eight great natural divisions, as follows:

1. *The Unakas*, on the eastern border, having an average elevation above the sea of 5,000 feet, and an area of 2,000 square miles. This division is too mountainous to be of much agricultural importance.

2. *The Valley of East Tennessee*, having an average elevation above the sea of 1,000 feet, and an area of 9,200 square miles. This division is a fluted region—a succession of parallel ridges and valleys—and one of the most beautiful, populous and fertile portions of the State.

3. *The Cumberland Table Land*, having an average elevation above the sea of 2,000 feet, and an area of 5,100 square miles. The soil of this division is thin, unproductive, and of no agricultural importance, but buried in the plateau are large quantities of coal and iron awaiting the construction of the Cincinnati Southern Railroad, large investments of capital, and a great demand, when it will become one of the important divisions of the State.

4. *The Highlands* that encircle the basin of lowlands in the center of this State, having an average elevation of 1,000 feet above the sea, and an area of 9,300 square miles. The soil of this division is of varying fertility, but altogether it is a region of considerable wealth and agricultural importance.

5. *The Central Basin*, having an average elevation of about 700 feet above the sea, and an area of 5,450 square miles. This is the best agricultural region in the State, and the center of wealth and civilization. It is called the Garden of Tennessee.

6. *The Valley of the Tennessee*, having an average elevation above the sea of 350 feet, and an area of 1,200 square miles. This division is irregular, swampy, sparsely settled, and in comparison with the last almost a wilderness.

7. *The Plateau of West Tennessee*, having an average elevation above the sea of 500 feet, and an area of 8,850 square miles. This is a great plain, that slopes gradually toward the Mississippi. The streams are sluggish, and the soil fertile, and capable of sustaining an immense population.

8. *The Mississippi Bottoms*, having an average elevation above the sea of 295 feet, and an area of 900 square miles. This is a low, alluvial

plain, with many lakes and morasses. The soil is of inexhaustible fertility, and when reclaimed from the dense forests and wild vegetation, will be the great center of agricultural wealth.

All the leading geological formations, from the metamorphic rocks to the Tertiary, are well developed. The soils are nowhere more varied, and the climate presents almost every phase from a tropical summer to a frigid winter. For the study of geology and mineralogy no State in the Union is more attractive.

More than one half of the State is yet covered with the unreclaimed forest trees, among which are the white ash, blue ash, red ash, water ash, beech, birch, red cedar (in the counties of Marshall and Bedford, solid cedar logs have been cut that would square twenty-four inches for a distance of thirty feet), chestnut, wild cherry, cotton wood, cypress, dog wood, white elm, slippery elm, wahoo, balsam fir, black fir, black gum, sweet gum, shell-bark hickory, thick shell-bark hickory, common hickory, pignut hickory, small-nut hickory, linn, black locust, honey locust, sugar maple, swamp maple, white maple, red mulberry, white oak, red oak, post oak, chestnut oak, black oak, scarlet oak, black jack oak, swamp white oak, overcup oak, yellow oak, chinquapin laurel oak, spanish oak, willow oak, bear oak, yellow pine, white pine, blue poplar, white poplar, yellow poplar, sassafras (a section of a sassafras tree exhibited at the Industrial Exhibition, in Nashville, measured five feet in diameter exclusive of the bark, which was one and a half inches thick), sycamore, tupello, white walnut, and black walnut. On the Cumberland table-land, in the eastern part of Morgan county, walnut trees grow six feet in diameter, and rise to the height of more than one hundred feet. One of the reasons that induced the city of Cincinnati to invest $10,000,000 in the Southern Railroad was to get access to this timber. [?] It is a curious fact, however, that a great deal of walnut timber is shipped from Ohio to the Eastern States, and even to Europe, and that the Tennessee timber will, sooner or later, be shipped direct to the Atlantic coast.

This work of the Bureau of Agriculture of Tennessee is much more valuable than the books generally published by State Boards of Agriculture, and is creditable alike to the industry and ability of its authors.

Indiana Geological Survey.—We are indebted to Dr. G. M. Levette for the Geological Survey of Indiana, for the year 1873, from which we take the following interesting matter relative to the Mound-Builders:

"It is not alone in Europe that we find a well founded claim, of high antiquity, for the art of making hard and durable stone, by a mixture of clay, lime, sand, and fragments of stone; for I am satisfied that this art was possessed by a race of people who inhabited this continent at a period so remote that neither tradition nor history can furnish any account of them. They belonged to the Neolithic or polished stone age. They lived in towns, and built mounds for sepulture and worship, and protected their homes by surrounding them with walls of earth and stone. In some of these mounds, specimens of various kinds of pottery, in a perfect state of preservation, have, from time to time, been found, and fragments are so common that every student of archæology can have a bountiful supply. Some of these fragments indicate vessels of very great size. At the Saline springs of Gallatin county, Illinois, I picked up fragments that indicated, by their curvature, vessels five to six feet in diameter, and it is probable that they are fragments of artificial stone pans, used to hold brine that was manufactured into salt by solar evaporation.

"Now, all the pottery belonging to the Mound-Builders' age, which I have seen, is composed of alluvial clay and sand, or a mixture of the former with pulverized fresh water shells. A paste made of such a mixture possesses in a high degree the properties of hydraulic Puzzuolava and Portland cement, so that vessels formed of it hardened without being burnt, as is customary with modern pottery. The fragments of shells served the purpose of gravel or fragments of stone, as at present used in connection with hydraulic lime in the manufacture of artificial stone.

"Instead of softening in water, as they would if made of clay alone, the shells give to the composition hydraulic properties, and vessels made of it harden on exposure to air and moisture. When filled with water and meat, pots made of this material could be placed over the fire and heated without fear of breaking them. These ancient artizans must have been aware of the advantage derived from a thin body to resist breakage from expansion and contraction from the heat of the fire. I have a beautiful vessel, from the 'Bone Bank,' made of artificial stone, which has ears, and is otherwise formed like an old fashioned cast-iron dinner-pot. It is five inches across the mouth, and seven inches in diameter at the bulge, five inches deep, and only one eighth of an inch thick. The bottom is smoked black, which goes to show that it was suspended over the fire for cooking purposes.

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Discovery of Dicotyles (Platygonus) compressus, Le Conte. By JOHN H. KLIPPART, of Columbus, Ohio.*

In the month of April, 1873, workmen were engaged in digging sand on the banks of the Olentangy river, at the crossing of Olentangy and Montgomery streets, in the corporate limits of the city of Columbus, Ohio; and in the course of their labors discovered, embedded in the sand, a "nest" of bones of some animal, to them unknown. A messenger was despatched with a basketful of these bones to my office, when I at once made arrangements to secure the entire lot, and whatever more might be discovered in the course of their excavations. A week later they advised me that they had discovered another "nest," which I secured also — going in person and superintending the removal.

These bones were exceedingly friable; in several instances a tibia broke, or rather crumbled, when made to support very little more than its own weight. The mass of bones were embedded in a calcareous clay, intermingled with a very generous quantity of calcareous sand. After carefully removing the bones from the clay in which they were embedded, they were placed in a kettle containing, say, four gallons of boiling water, in which one pound of the best glue had been dis-

*Read before the American Association for the Advancement of Science, at its meeting at Hartford, August, 1874.

solved; and kept at the boiling point for the space of one hour after the bones were immersed. Nearly all the bones treated in this manner were restored to a comparatively great degree of firmness and solidity; more especially such ones as were fractured, or in which the internal structure was exposed. But this process — the only one with which I am acquainted for the purpose of restoring the gelatine to the bones—has its disadvantages. I found that nearly all the "*bases*" and "*heads*" of femurs, humeri, ulnæ, and other bones, separated from the shafts; and it was by no means an easy process to replace and unite them again.

Before proceeding to give a detailed description of the bones, it is, perhaps, not inappropriate to describe the geological formation of the locality in which they were found. From the northern boundary of Delaware county, until near its junction with the Scioto river, within the city limits of Columbus—a distance of about thirty-five (35) miles—the Olentangy, flowing nearly due south, flows on the outcrop of the Huron shales; the left bank being the shale outcrop, and often somewhat precipitous. In this shale bank or outcrop, septaria abound: the extremes in size of these septaria range from two inches in diameter, or perhaps even less, to more than ten (10) féet in diameter; those from one to two feet in diameter being the most abundant. The right bank of the Olentangy is of "valley drift," and beyond it, westward, for many miles, the surface of the country is very level.

About eight miles west of the Olentangy, on the north boundary of Delaware county, is the Scioto river, which flows a little to the east of south, so as to unite with the Olentangy in the city of Columbus. The Scioto, however, flows over a bed of corniferous limestone. The valley between these two streams, as well as the country for miles east and west of it, is covered with a deep drift. When boring the artesian well in the State House yard, this drift was found to be one hundred and twenty-three feet thick at that point. But the drift on which the State House and the city in its immediate vicinity are built, differs very materially from that in which the remains or bones were found. The one hundred and twenty-three feet of material deposited on the fifteen feet of shale, which intervenes between it and the corniferous rock, is material undoubtedly due to the action of glaciers and icebergs. From a record kept at the time of boring the artesian well above mentioned, the augur passed through the following thirteen strata:

	Ft. from surface.	Ft. in thickn's	Strata.		Ft. from surface.	Ft. in thickn's.	Strata.
1	1	1	Surface earth.	8	42	18	Blue clay.
2	3	2	Brown loam.	9	45	3	Clay and gravel.
3	14	11	Gravel and sand.	10	50½	5½	Quicksand.
4	18	4	Blue clay.	11	54½	4	Clay and gravel.
5	20	2	Common sand.	12	123	68½	H'd pan, cemented clay, sand & gravel
6	23	3	Quicksand.	13	138	15	Shale and slate.
7	24	1	Leafy blue clay and sand.				

These strata, or rather deposits, with the exception of Nos. 6 and 10, are exceedingly inconstant. Within two squares from the artesian well, No. 3 has diminished on the southward to less than three feet, and 5 and 6 are entirely wanting; on the northward it is less than half as thick as at the well, and rests upon yellow clay. The irregularity in thickness of these strata, the disappearance of some in short distances, the appearance of others not in the series at the well, are evidences of the deposits not being subjected to the assorting action of water, and therefore I conclude they were deposited by glaciers and icebergs; and I prefer to ascribe the deposit, at least the lower seventy-five feet, to glacial action. I think there can be little doubt that the valley of the Scioto, that is that area extending from the left bank of the Olentangy to the right bank of the Scioto, is certainly due to glacial action. At Mr. Little's quarry, in the town of Delaware, about a mile west from the right bank of the Olentangy, and at a slight elevation above the bed of the stream, was found a quartzite bowlder, at the terminus of a great groove which it had ploughed; and in so doing had broken into fragments and displaced many of the upper thin strata of the quarry. This quarry is in the upper portion of the corniferous limestone. Erratic, or drift bowlders, are found throughout the material on which the city of Columbus is built—are found beyond the banks of the Scioto as well as in the valley.

There is no doubt that the line of drainage of the Olentangy and Scioto, from their entrance into Marion county, the former on the eastern boundary and the latter on the western, to their junction at Columbus, in Franklin county, is due to glacial action; and that the entire area embraced between them, throughout this distance, was once a single sheet of water, and whilst in this situation the waters did much erosive work. During the subsequent submersion, this "bay" was filled up with eroded material from higher grounds, and was "worked over," *assorted*, and deposited in such strata as we now find it. When it emerged, the old line of drainage was resumed, but as the volume of water had vastly diminished, two small streams were formed, the Olentangy occupying the eastern bank of the former stream and the Scioto occupying the western. Then came another submergence, and during this period there was deposited a stratum of clay, varying in places from two to five feet in thickness. This last stratum of clay is found superimposed on the strata of sand in the valley, as well as on the higher table lands, thus presenting indisputable evidence that the clay was deposited after the valley had assumed its present form, so far as its precise topography is concerned. Fig. 1 presents a section taken from the State quarry, along the line of the "Shortline" railroad, and above the junction of the Olentangy with the Scioto. The line "E" is the surface of the ground on the line of the Shortline road; the dotted line "D" is some rods north of the railway and is at the junction of Olentangy and Montgomery streets, where the remains were found. D to E is a gentle declivity.

Fig. 2 represents a section taken diagonally across the corner of the lot from Montgomery street to Olentangy street. After having penetrated about twenty (20) feet from the opening of the bank, and at a depth of eight (8) feet from the surface, the remains of six of the smallest animals were found embedded in the calcareous clay and sand, as indicated at "A"; after proceeding some six feet farther and four feet deeper, the remains of the six larger animals were found at "B." The digging proceeded from southeast to northwest; the "*snouts*," or rather the tusks, were the first portions of the skeleton which presented themselves. The group of remains marked "B" were almost directly under a side track of the railway on Olentangy street, and further excavation in that direction could not be made without endangering the safety of the track. In order to obtain this last group of remains it was necessary to deviate from the northwest to a due north course, thus presenting a square east and west face of the deposits or formation. This face presented the matter in a new light; it was observed that the strata immediately above the remains were confused, presenting evidence of disturbance, so far as the deposits of sand and gravel were concerned, whilst the overlying clay was, so far as the eye could discern, entirely intact or undisturbed.

The animals were lying side by side, with their heads toward the southeast; their death was sudden and violent, the jaws were crushed, skulls fractured, the left side of one lower jaw was driven into the palate, and various other evidences of sudden and violent death were manifest. On the contrary, there was no evidence whatever that the animals were destroyed by other, or carnivorous animals, and then dragged into the burrow, which evidently existed when the animals were placed there. The bones are entire, except where broken from very manifest pressure; they present no appearance of having been gnawed, or "*crunched*." In fact, a portion which I succeeded in keeping intact, except to remove the earthy matter, proved to be a portion of the spine, with the scapulæ in proper position, humeri, radiæ and ulnæ; the metacarpal bones all in proper position, and the articulations were apparently not disturbed since the embedding or death of the animal. The evidence—the undisturbed condition of upward of two feet of superincumbent clay—is to the effect that the animals met their fate and were embedded before the last submergence of this portion of the globe.

These bones are the remains of what animal?

These remains or bones are those of an animal of the family Suidæ. This is evident from the structure of the feet, which in this family have three or four toes, two median, and one or two shorter lateral, shod with hoofs, and the lower incisor teeth, which are beveled forward. A comparison of the fossil skull—although not fossil in the ordinary acceptance of the term, yet fossil, because "dug out of the ground"—with that of the domestic hog shows, however, generic differences. The skull is more conoidal as regards both cranium and face, presenting no marked angles in common with that of the hog. The median line is convex, its highest point some distance in front of the occiput. There is no intertemporal space; the temporal ridges meeting to form a crest. The superior portion of the occiput is relatively much smaller than in the hog. There is an interval of nearly two inches between the canines and premolars, the former being shorter, stouter, and less curved than in the hog. The molars and premolars are arranged in straight lines, those on opposite sides parallel, the palate is very narrow, an inch only in width between the teeth. In front of the superior canines is a deep triangular fossa in which rest the inferior canines in the closed mouth, so that these teeth are covered by the upper lip and probably never lie external to it, or become as long as in the hog. Perhaps the most important osteological character is the formation and position of the glenoid cavity for articulation with the lower jaw. It is concave and comparatively very small, being only $\frac{7}{10}$ths of an inch in median transverse diameter, and situated in the middle of the zygomatic arch 1.3 ($1\frac{3}{10}$th) inches in front of the styloid process. In the hog this process is an inch wider, flat, and rests upon the posterior root of the zygomatic arch, and impinges upon the body of the temporal bone, and its posterior border lies on nearly the same transverse plane as the styloid process. Other peculiarities might be noticed, as, for instance, the comparatively large external auditory meatus, occupying a position much anterior and inferior to that of the hog. The orbit is more nearly closed by bone than in the hog.

These differences seem to indicate an animal more carnivorous than the hog, while the comparative smallness of the superior portion of the occiput suggests less of a rooting disposition. I may here suggest, that, could it be shown that, in his day, large mollusks abounded in the soft bottoms of shallow streams and estuaries, the conditions of his comfortable existence would seem to have been fulfilled.

A comparison with other living genera of this family shows a very near relationship to the peccaries. Prof. J. S. Newberry assures me that in a comparison with the skeleton of the Mexican and the South American peccary, it is found to be twice as large as the Mexican, and a little larger than the South American. No detailed comparison of the entire skeleton has yet been made, but, on comparing the heads of the different species, there are differences apparently sufficient to constitute *three* distinct species, making the fossil one under discussion a new species. The most striking peculiarities, however, of the head of the fossil species are the small incisors, somewhat larger canines, thinner and more compressed form of head, the eversion of the lower and posterior angles of the lower jaw.

Portions of this fossil animal have frequently been found in several States of the Union, but there is no record of anything more than a portion of a jaw or a cranium found in any one locality. To find a round dozen of nearly entire skeletons in one locality is therefore most extraordinary, and I hope and trust that out of this quantity of material some comparative anatomist will not only determine its place in the scale of creation, but will make a precise description of it.

Monograph of the Class Brachiopoda of the Cincinnati Group.

The class *Brachiopoda* was proposed by Cuvier in 1805, for bivalve shell-fish having a pair of long, ciliated and usually spiral arms, by the action of which a current of water is produced that carries the particles of food to the mouth, which is situated close to the base. In 1814, Blainville proposed the name *Palliobranchiata*, for the same class, which is used by some naturalists in preference to *Brachiopoda*. They are distinguished from the *Lamellibranchiata* by the absence of any special branchial apparatus, the respiratory function being performed by the mantle, and by the structure of the shell.

They are all marine shells, equal sided and inequivalve. The valves, instead of being placed on each side of the animal as in the *Lamellibranchiata*, are situated above and below it; so that they are called *dorsal* and *ventral*, instead of *right* and *left* valves. The ventral valve is usually larger than the dorsal and projects beyond it at the beak, where it is generally perforated to allow the passage of the attaching ligament. Sometimes, however, the shell is attached by the beak, and in other cases, as in the *Lingulidæ*, the attaching peduncle passes out between the umbones. The dorsal valve is always free and imperforate.

The valves are usually articulated by two curved teeth, springing from the ventral valve and locking into corresponding cavities in the dorsal valve. In *Crania* and some other genera having a flat ventral valve, usually adherent, the hinge line is destitute of teeth. The valves are opened by the "cardinal muscles," and closed by the adductors. The body of the animal usually occupies only a small portion of the cavity of the shell, close to the hinge.

With the exception of the corals, more than three fourths of all the fossils found in the Cincinnati Group belong to this class.

In the preparation of this Monograph, I have used the best definitions of the species accessible, and particularly the re-definitions by Prof. Meek in the Ohio Paleontology.

The following are the characters ascribed to this class by Prof. McCoy:

"This class contains a large group of symmetrical, usually thin, sharp-edged shells. The border of the mantle is little developed, and the group derives its name from two long arms, one on each side of the mouth, which may be regarded as an enormous development of the labial palpi of *Lamellibranchiata*, among which *Anomia* alone shows anything approaching the same development. These arms are hollow tubes, coiled or doubled up, and capable of a greater or less protrusion by the contraction of a doubly oblique set of muscular fibers, with which they are coated, acting on the fluid contained within them; they unite in front of the mouth, and have their outer margin fringed with filaments, the motion of which, whether protruded beyond the shell or not, is supposed to produce a strong current of water, conveying nutrient particles toward the mouth; the absence in them of large blood vessels shows they are not respiratory. The edge of the mantle is also fringed with long, fleshy, or semi-corneous filaments, covered, like the surface, with microscopic ciliæ, and exciting currents of pure water over the surface for respiration, the blood being exposed to it in four thick, branching pallial vessels in the lower, and two similar in the small or upper valve; these great vessels communicate with a vascular sinus, ventricle, or heart, on each side of the body, and from the opposite ends of these hearts come the vessels supplying the viscera. *Digestion:* the mouth is in the middle, close to the base of the arms, leading *(in Terebratula)* by a short *œsophagus* into a wide stomach, surrounded by a liver or group of hepatic follicles; the stomach bending a little, ends in a short, straight intestine (convoluted in *Lingula*), terminating on the right side. *Nervous system*: a nervous collar, with small ganglionic swellings surrounds the œsophagus, and gives off twigs to the mantle and the adductors."

The *Brachiopoda* found in the Cincinnati Group belong to the following families: *Lingulidæ, Craniidæ, Discinidæ, Rhynchonellidæ, Orthidæ, and Spiriferidæ.*

Family *Lingulidæ*—(D'Orb).

Arms free, fleshy, inrolled, without shelly supports from the valves, capable of being entirely protruded beyond the shell, provided with long, firm fimbriae; valves unconnected by a hinge; pedicle of attachment passing out between the beaks of the two valves, neither of which are notched or perforated. Shell corneous, dense, fibrous, subequivalve, equilateral. There is a heart-like vessel on each side, about one third the length from the beak, giving off one large trunk on each side; the subdivisions of the branchial vessels give off vascular loops, arranged as separate lobes of the mantle, resembling the gills of the higher *Mollusca*, and subservient to respiration; close to the beak are the conjoined impressions in each valve of the posterior pair of muscles; at about one third the length of the shell in front of them are two small, ovate, approximate ovaries, exterior to which are the large impressions of the decussating muscles which produce the sliding motion of the valves on each other. Just in front of the ovaries are two very large oval lobes of the liver, a third lobe of which is placed in the median line immediately in front of the posterior pair, and is flanked on each side by a rather small, oblique, ovate impression of the anterior pair of adductor muscles in each valve; considerably in front of these, in the median line, are the conjoined, triangular impressions of the anterior pair of muscles, which extend into the pedicle at the posterior end.

This family includes among other genera, the *Lingula* and *Leptobolus*.

Genus *Lingula*—(Bruguiere, 1792).

[*Etym.*—*Lingula*, a little tongue.)

Subequivalve, equilateral, longitudinally ovate or subpentagonal, both valves channeled equally at the beaks, for the passage of the pedicle (one beak a little longer and more pointed than the other, which latter has a narrow, internal, flat area); internally, each valve has a thickened pad in the middle, and the shorter one has in front of it a prominent internal septum.

The species of this genus grow wider proportionally with age.

Lingula quadrata—(Eichwald, 1829).

Subequivalve, equilateral, broadly oval, depressed convex; sides nearly straight and parallel, or slightly curved; extremities nearly equal in width, the first broadly rounded, cardinal extremity slightly narrower and somewhat angularly sloped; beak marginal, not prominent; exterior surface of the shell marked by strong concentric striæ, and along the middle by distinct longitudinal striæ, which are equally visible when the outer shell is exfoliated. A longitudinal depressed line marks the shell from the beak nearly half way to the base.

It is distinguished by its very large size and subelliptical form. It varies in length from one inch to an inch and a half, and in width from three fourths of an inch to an inch.

Its range is co-extensive with the Cincinnati Group, but good specimens are extremely rare.

Lingula Van Hornei—(S. A. Miller)

Fig. 1.—*Lingula Van Hornei.*

General form acute, elongate ovate; beak of dorsal valve projecting beyond the beak of the other valve; valves about equally convex along the middle and compressed toward the front; surface marked with concentric lines.

Length of specimen, 0.75 inch; greatest width, 0.47 inch; convexity, 0.18 inch.

Where the shell is exfoliated from the anterior half of the dorsal valve, lines are shown radiating from a depression, in the middle part of the cast of the interior, which terminate before reaching half way to the lateral margins; and also two curving lines or depressions situated about half way from the middle to the lateral margins and coming together in the middle, near the anterior margin.

A groove marks the median line of the cast of the interior of the smaller or ventral valve for more than half its length; it commences below the beak, at about the line of the first quarter, and terminates within the last quarter.

Found from 400 to 600 feet above low water-mark. The specimen figured I found at Versailles, associated with *Anomalodonta gigantea*, about 300 feet below the Upper Silurian rocks. It is quite rare.

The specific name is given in honor of Mr. W. C. Van Horne, a gentleman of no ordinary paleontological attainments, now a resident of LaCrosse, Wisconsin, and General Manager of the Minnesota Southern Railroad.

Lingula Norwoodi—(James).

Fig. 2.—*Lingula Norwoodi.*

Shell elliptical in outline; regularly convex; surface marked by concentric lines; beak rather prominent.

Length, about $\frac{3}{16}$ths inch; breadth, $\frac{2}{16}$ths inch.

Named in honor of Prof. J. G. Norwood, of Columbia College, Missouri, formerly State Geologist of Illinois.

This beautiful little species was found by Mr. U. P. James, near Cincinnati. Range unknown.

Genus *Leptobolus*—(Hall, 1871).

[*Etym.*—Minute and obolus.]

Shell semi-phosphatic, fragile, minute, more or less elliptical, ovate or subcircular, with moderately (or sometimes more extremely) convex valves, which are concentrically marked on the exterior surface; ventral valve with a distinct area and pedicle groove; interior with an elevated subquadrate muscular area; dorsal valve a little thickened on the cardinal margin, with slightly elevated, trifid, muscular impressions.

Leptobolus lepis—(Hall, 1871).

Shell minute, ovate, or broadly elliptical in outline, about $\frac{3}{5}$ths as wide as long, and seldom exceeding $\frac{7}{100}$ths of an inch in length; moderately convex, the greatest convexity being about one third of the length from the beak; ventral area thickened; pedicle groove strongly defined; muscular impression broad, extending more than one third the length of the valve; muscular ridges of the dorsal valve strongly marked, the central one extending two thirds the length of the shell, the lateral ones diverging from each other at an angle of about 45°, and extending nearly to the middle of the valve; extremities bifid. Surface of the valves concentrically marked by fine lines of growth.

Found on the clay nodules below Mowry's foundry, in the first ward of the city of Cincinnati, within twelve feet of low watermark, associated with *Leperditia Byrnesi* and *Lichenocrinus crateriformis* Its range, so far as known, is confined to the lower rocks of the Cincinnati Group.

Family *Craniidæ*—(D'Orb).

Shell thick, pyramidal, calcareous, without muscle of attachment; free or fixed by the substance of the lower or ventral valve; arms spirally fixed among themselves, not extensile, nor supported by apophyses; thickened margin of the valves, with ramified impressions of the fimbriated edge of the mantel.

This family includes the genera *Crania* and *Pholidops*.

Genus *Crania*—(Retzius, 1781).

[*Etym.*—*Krancia*, capitate.]

Shell variable in shape, inequivalve, circular, subquadrate, transverse or elongated, partially or extensively attached by the substance of its lower or ventral valve; rarely free; upper or dorsal valve more or less conical, vertex subcentral; no articulated hinge or ligament, the valves being kept in place by the action of four muscles, which pass in a somewhat oblique manner from one valve to the other; the attached or ventral valve is generally the thickest, with or without a straight more or less produced beak, and false area. External surface smooth, spiny, or variously ornamented by radiating costæ or foliaceous expansions; the concentric lines of growth passing uninterruptedly over the valves and area; structure calcareous and tubular. In the interior, four principal scars formed by the adductor muscles are observable. The anterior pair are approximate and placed close to the center, behind which a prominence is sometimes visible in the ventral valve. The posteror pair are situated near the cardinal edge, and are widely separated. The muscular impressions of the attached valve are sometimes slightly convex, at others deeply excavated; those of the dorsal valve are convex, the center pair sometimes developing very prominent apophyses. The interior of the attached valve is surrounded by a raised and thickened border, exhibiting the tubular shell structure in a conspicuous manner. The disk of each valve exhibits more or less distinct impressions of the vascular system, which is simply digitated.

Crania scabiosa—(Hall, 1866).

Shell somewhât less than medium size, usually discoid or little elevated, but sometimes prominent, irregular in outline; margin thickened, apex of dorsal valve eccentric, varying in different individuals. Surface of valve having usually strong lamellose lines of growth, which are sometimes obscured by the roughness of the substance to which the specimen is attached, showing through the shell or causing it to grow irregularly, by which it often assumes the features of the foreign body. Interior showing the two anterior muscular impressions situated posterio-centrally, and the two posterior muscular impressions a little farther separated from each other, and situated close to the cardinal edge.

It is a common fossil throughout the Cincinnati Group, at all elevations above 200 feet from low water-mark.

Crania lælia—(Hall, 1866).

Shell small, discoid or moderately convex on the upper valve, somewhat narrowed toward the cardinal border. Apex of the dorsal valve minute, not prominent, situated about one third the length of the valve from the cardinal margin.

Surface marked by fine but very sharply elevated radiating striæ, which are sometimes tortuous, and frequently increased by implantation; ventral valve and interior unknown.

It was first found at Cincinnati, about 400 feet above low water-mark, and extends from thence to near the Upper Silurian rocks. It is not, however, a common fossil.

Crania Dyeri—(S. A. Miller).

Fig. 3.—*Crania Dyeri.*

Shell small, circular; dorsal valve prominent, conical; apex central. Surface marked by six or seven fine, sharply elevated, concentric ridges or lamellose lines of growth. Ventral valve and interior unknown.

Diameter of specimen, 0.20 inch; convexity, 0.07 inch.

Found within 250 feet of low water-mark, at Cincinnati. Extremely rare.

The specimen figured is from the magnificent collection of C. B. Dyer, Esq., in whose honor I have given the specific name.

Crania multipunctata—(S. A. Miller).

Fig. 4.—*Crania multipunctata.*

Shell small, subrectangular or irregular in outline; dorsal valve moderately prominent; apex subcentral or about one third the length of the valve from the cardinal margin.

Surface marked by numerous fine punctures, just visible to the naked eye, but giving the shell a highly ornamental appearance under an ordinary magnifier. Ventral valve and interior unknown.

Length of specimen, 0.32 inch; width, 0.24 inch; convexity, 0.07 inch.

The specimen figured I found near the upper part of the hills in Cincinnati. Mr. C. B. Dyer has a specimen, collected in the same range, and it is so in the collection of U. P. James, Esq.

Genus *Pholidops*—(Hall, 1859).

Shells small, patelliform; apex subcentral, eccentric or terminal. Surface marked by concentric lamellæ of growth, which are more expanded on the posterior side. Interior a shallow oval cavity, with bilobed muscular impressions; the margin flattened or slightly deflected and entire.

Pholidops cincinnatiensis—(HALL, 1872).

Shell small, ovate in outline. Larger valve about one fifth longer than wide, with height one third to one fourth the breadth. Apex obtuse, near half way between the middle and the larger end. Anterior end narrowly rounded, posterior end somewhat more broadly rounded, or almost subtruncate. Surface ornamented by six or seven subimbricating marks of growth. Smaller valve unknown.

Length, 0.14 inch; breadth, 0.12 inch; height of larger valve, 0.04 inch.

This species is quite rare, and yet it has been found, at Cincinnati, at nearly all elevations, from low water-mark to the top of the hills, back of the city. Its range is, therefore, not limited to less than half the thickness of the Cincinnati Group, and is probably more extended.

Family *Discinidæ.*

Animal attached by the means of a muscular peduncle, passing through the ventral or lower valve, a slit in the hinder portion, or a circular foramen excavated in the substance of the same valve. Arms fleshy; valves unarticulated.

This family includes with other genera the genus *Trematis.*

Genus *Trematis*—(SHARPE, 1847).

Animal unknown; shell somewhat depressed, suborbicular or transversely oval; both valves slightly and unequally convex, giving a lenticular form to the shell; umbo of the upper or imperforated valve submarginal, slightly projecting. Lower or ventral valve with a subcentral umbo, behind which a narrow, oblong, oval slit reaches to near the posterior margin, and afforded passage to the pedicle fibers of attachment.

Internal disposition unknown; a wide cardinal margin is visible in the imperforated valve.

Trematis terminalis (?)—(CONRAD, 1847).

Shell very obtusely subovate or orbicular; ventral valve nearly flat, with a narrow, deeply depressed pedicle opening about one fourth the length of the shell and extending to the margin of the shell beneath the beak of the other valve; dorsal valve very convex in the middle and posterior regions, and depressed anteriorly; beak pointed and projecting beyond the opposite valve.

Outer shell of both valves very thin and smooth about the beak and umbonal regions, but regularly punctate on other parts in lines radiating to the margins. Where the nonpunctate shell is exfoliated, no radiating striæ or punctate structure is visible; but where the punctate shell is exfoliated, the inner shell, to the unaided eye, appears to be marked by regular radiating striæ, with fine puncta between them. A magnifier, however, shows the radiating striæ to be only the lines between the furrows, produced by the punctate structure.

Length of the largest specimen known to me, 0.82 inch; width, 0.84 inch; convexity, 0.22 inch.

This specimen may belong to a new species, so I have referred it to Conrad's species, with a doubt. It is rare and its range unknown.

Trematis (?) *filosa*—(Hall, 1847).

Shell orbicular; dorsal valve very convex, greatest convexity in the central part and sloping in all directions; beak marginal; surface radiated with numerous, fine, elevated, thread-like striæ, which are alike visible on the exterior and interior part of the valve; striæ increased by intercalation. Interior marked by two rather large, subcircular, muscular impressions, situated a little anterior to the beak, and separated by the median line. Ventral valve unknown.

Length of a large specimen, 0.54 inch; width, 0.56 inch; convexity, 0.30 inch.

Found on the hills back of Cincinnati, and at many other places, but its range is not very definitely known. Good specimens are quite rare.

This species evidently belongs to a new genus or a sub-group under the genus *Trematis*. The character of the two muscular impressions, and the absence of the punctate structure in the outer shell, that characterizes both the *terminalis* and *millepunctata*, must separate this species, at least, subgenerically, from all other shells found in the Cincinnati Group.

For *Trematis Dyeri*—(S. A. Miller), see vol. 1, page 347, of this Journal, October, 1874.

Trematis millepunctata.—(HALL, 1866).

Shell suborbicular, transverse on the ventral side and lenticular in profile, and varying in size from one quarter to one half inch or more in diameter.

Ventral valve strongly convex below the middle, more depressed above; with a narrow, deeply depressed pedicle opening, the margins of which are flattened for a space nearly equal to the breadth of the opening.

Dorsal valve more elongate, most convex above the middle; the beak pointed and projecting considerably beyond the opposite valve; with a depressed or concave triangular area.

Interior of the dorsal valve marked near the middle by two comparatively large, semicircular or reniform muscular scars, the breadth across the two more than equal to one third of the diameter of the valve; the center of the valve has also a slight mesial septum.

Surface strongly punctate in concentric curves passing from the center of the shell outward, extending through the shell near the front of the valves, and distinctly marking the cast; inner layers of the shell not punctate.

It differs from the *T. terminalis*, in being more transverse, with a less convexity of the ventral valve and more prominent beak of the dorsal valve; and also in the character of the punctate structure. The Trenton species is distinctly punctured, the puncta passing through the shell, showing most distinctly on partially exfoliated specimens; while in this species they are entirely confined to the exterior layers of the shell. It is also destitute of the radiating striæ found in *T. terminalis*, when the shell is partially exfoliated.

The largest specimen known to me is 0.82 inch in length; 0.92 inch in width; and 0 28 inch in convexity.

Family *Rhynchonellidæ.*

Shell impunctate, oblong, or trigonal, beaked; hinge line curved; no area; valves articulated, convex, often sharply plaited; foramen beneath the beak, usually completed by a deltidium, sometimes concealed; hinge teeth supported by dental plates; hinge plate deeply divided, supporting oral lamellæ, rarely provided with spiral processes; muscular impressions grouped as in *Terebratula;* vascular impressions, consisting of two principal trunks in each valve, narrow, dichotomising, angular, the principal posterior branches inclosing ovarian spaces.

Genus *Rhynchonella*—(Fischer, 1809).

Shell trigonal, acutely beaked, usually plaited; dorsal valve elevated in front, depressed at the sides; ventral valve flattened or hollowed along the center; hinge plates supporting two slender, curved lamellæ; dental plates diverging.

Rhynchonella capax—(Conrad, 1842).

Shell medium size, varying with age from compressed subtrigonal to large subglobose, old examples being often more convex than their diameter in any other direction; posterior lateral margins somewhat straightened and converging to the beak, at about a right angle in young shells, but becoming more rounded in the adult; lateral margins rounding to the front, which is more or less distinctly sinuous, or nearly straight in the middle.

Dorsal valve generally a little more convex than the other, most prominent in the middle, and rounding abruptly, or sloping more gently from the central region in all directions; the more elevated part forming, anteriorly, a depressed mesial ridge, that is nearly flat, and occupied by four plications on top, and rarely continues two thirds of the way to the strongly incurved beak, while on young or compressed individuals it is faintly marked even anteriorly; lateral slopes each occupied by four to seven or eight simple, angular plications.

Ventral valve with its beak abruptly pointed, and very strongly incurved upon that of the other valve, in adult shells, but less distinctly curved, and showing a small opening under its apex, in young examples; mesial sinus deep and well defined in gibbous specimens, and less so in the young or more compressed forms, never quite reaching the point of the beak, and always having three simple, rather angular plications in the bottom, that extend, like the others, to the apex of the beak, in well preserved specimens; lateral slopes each occupied by from five to seven simple plications.

Entire surface of both valves marked by numerous, very regular, strongly zigzag, prominent, sublaminar marks of growth, that become nearly or quite obsolete, sometimes, on old examples.

Its range is confined to the rocks constituting the upper 250 feet of the Cincinnati Group, but it is the most abundant and common fossil within that range, and one of the best preserved. It can be picked up almost anywhere north of the Ohio river, from 40 to 60 miles from the city of Cincinnati.

Rhynchonella dentata—(Hall, 1847).

Shell rather smaller than the medium size in this genus, trigonal-subglobose, generally slightly wider than long, and usually, in adult examples, quite convex; posterior lateral margins nearly straight, or a little convex in outline, and converging to the beaks at nearly a right angle; anterior lateral margins rounded or subangular; front usually a little sinuous, as seen in a direct view of either valve.

Dorsal valve more convex than the other, particularly in the anterior central region, where it is often very prominent, being elevated in the form of a distinct mesial ridge, that is divided into two plications by a central furrow; lateral slopes rounding off more or less abruptly, and each occupied by from four to five simple, rather angular, radiating plications; beak strongly incurved.

Ventral valve (as seen in a side view) somewhat strongly arched from beak to front, or more or less compressed in the central region, and abruptly curved up at the front and beak; mesial sinus commencing small near the beak, and widening and deepening (with sloping sides and a single central plication) to the front, where it equals about one half the entire breadth, and terminates a more or less produced, subtrigonal marginal projection, curved up nearly at right angles to the plane of the valve, and fitting into a corresponding sinus in the edge of the same; lateral slopes generally quite abrupt from the edges of the mesial sinus, and each occupied by about five single subangular plications; beak incurved, but not so closely upon that of the other as to conceal the small foramen under its apex.

Surface of both valves with the plications continued to the points of the beaks, and imparting to the interlocking anterior margins, a sharply zigzag outline; while on well preserved specimens, very fine, obscure lines of growth may be seen, by the aid of a magnifier, crossing the plications and furrows between them, parallel to the zigzag anterior and lateral margins; though these lines are nearly or quite obsolete, excepting near the front.

Found at Richmond, Indiana, and at other places in the upper 100 feet of the Cincinnati Group, in moderate abundance. The *R. capax* commences a hundred feet lower, and has passed its turning point of greatest abundance before this species appears in the rocks.

Family *Orthidæ* (sometimes written *Orthisidæ*).

Shell transversely oblong, depressed, rarely foraminated; hinge line wide and straight ; beaks inconspicuous; valves plano-convex or concavo-convex, each with a hinged area notched in the center; ventral valve with prominent teeth; muscular impressions occupying a saucer-shaped cavity, with a raised margin; adductor central; cardinal and pedicle conjoined, lateral, fan-like; dorsal valve with a tooth-like cardinal process between two curved brachial processes; adductor impressions quadruple; vascular impressions consisting of six principal trunks in the dorsal valve, two in the ventral; the external branches turned outward and backward, inclosing wide ovarian spaces. Indications have been observed, in several genera, of horizontally coiled, spiral arms; the space between the valves is often very small. The shell structure is punctate, except in a few instances, where the original texture is probably obliterated.

Some authors prefer to classify the shells of this family under the name *Strophomenidæ.* It includes, with other genera, the *Orthis Hemipronites, Strophomena, and Leptena.*

Genus *Orthis*—(Dalman, 1827).

[*Etym.—Orthos*, straight].

Shell variable in shape, suborbicular or quadrate; valves equally or unequally convex; socket valve sometimes slightly concave, with or without a mesial fold or sinus; hinge line straight, generally shorter than the width of the shell; both valves furnished with an area, divided by a triangular, open fissure, for the passage of the pedicle fibers; beaks more or less incurved—that of the larger valve generally more produced; surface smooth, striated or ornamented by simple bifurcated or intercalated ribs; structure minutely or largely punctated; valves articulating by means of teeth and sockets. In the interior of the larger, or ventral, valve the vertical dental plates form the walls of the fissure, and extend from the beak to the bottom of the shell; between these a small, rounded mesial ridge divides the muscular scars, which extend over two elongated depressions, margined on their outer side by the prolonged bases of the dental plates; the cardinal muscles appear to have occupied the greater portion of the anterior divisions of these two depressions, the pedicle muscles occupying the external and posterior part of the same space; the adductor was probably attached to each side and close to the mesial ridge. In the socket valve the fissure is partially or entirely occupied by a more or less produced simple shelly process, to which were affixed the cardinal muscle fibers; the inner socket walls are considerably prolonged into the cavity of the shell, under the shape of projecting laminæ, to the extremity of which free, fleshy, spiral arms may, perhaps, have been affixed. Under this shelly process, a longitudinal ridge separates the quadruple impressions of the adductor, which on each side forms two deep, oval depressions, placed obliquely one above the other, and separated by lateral ridges branching from the central one; the pallial vessels, as well as their numerous minor bifurcations or veins, have often left impressions within the valves; the principal trunks seem both more numerous and better defined in the socket valve; after extending in a somewhat radiate or sub-parallel direction from the muscular scars to near the anterior region, they sweep round sub-marginally on both sides of the valve, leaving wide ovarian spaces and giving off a series of smaller branches.

Orthis testudinaria—(Dalman, 1827).

Suborbicular, plano-convex; cardinal line straight, shorter than the width of the shell; ventral valve convex, much elevated toward the beak, often with an elevated ridge down the center; beak small, slightly incurved; dorsal valve flat, or with a longitudinal depression along the center, which often produces an emargination in front; cardinal area small; foramen small, triangular; surface covered with fine striæ, which bifurcate toward the margin, and are crossed by elevated, thread-like lines, giving them a crenulated appearance. In the interior of the dorsal valve the cardinal process is situated between two small, projecting, deviating, brachial laminæ, while the quadruple muscular impressions are small, and divided into parts by a rather wide mesial ridge. In the ventral valve the muscular area is moderately developed, elongated, and forked in front.

It is generally supposed to be common throughout the Cincinnati Group, at all elevations, but forms usually classed with it in the lower half of the group, now bear other names. Its range may, therefore, be restricted to the upper part of the group, unless the *multiseeta* and *Meeki* are regarded as varieties only. And, indeed, there is no form found within the Cincinnati exposure that exactly agrees in the size and situation of the muscular scars with the European specimens, and it might be proper to class even the form that prevails in the upper part, which most resembles the type specimens of Europe, as a variety under a distinct name.

Orthis Meeki—(S. A. Miller).

Shell small, plano-convex, rather depressed, transversely truncato-suboval, the length being about five sixths its breadth; hinge line, perhaps, always a little shorter than the greatest breadth of the valves; lateral margins generally rounding to the hinge, most prominent at, or a little behind, the middle, and rounding to the front, which is usually somewhat straightened, or very faintly sinuous at the middle; or, presents a regular semi-circular outline.

Dorsal valve nearly flat, or slightly convex on each side of a shallow, mesial sinus, that commences very narrow at the beak, and usually widens rather rapidly to the front; beak very small, scarcely projecting beyond the edge of the area, and not incurved; area low at the middle, and narrowing off to nothing at the lateral extremities of the hinge, slightly arched, and directed obliquely backward; foramen very small, and filled by the cardinal process. Interior very shallow, and provided with a slender mesial ridge that extends about half way forward from the hinge, between the muscular impressions, which are not usually well defined; scars of posterior pair of adductor muscles smaller, and usually deeper, than the anterior, and situated close back under the brachial processes; those of the anterior pair three or four times the size of the posterior, suboval in form, and extending to near the middle of the valve; cardinal process very small and trifid; brachial processes, comparatively, rather stout and prominent; internal surface having the radiating striæ of the exterior rather distinctly impressed through, as it were, in consequence of the thinness of the shell, and finely granular, the granules being apparently connected with the punctate structure of the shell.

Ventral valve compressed convex, the greatest convexity being near, or a little behind, the middle, along a more or less prominent undefined ridge, that sometimes, but not always, imparts a subcarinate appearance to the central and umbonal regions; beak small, projecting somewhat beyond that of the other valve, abruptly pointed, and rather distinctly arched, but not strongly incurved; area about twice as high as that of the other valve, and with its sharply defined edges sloping to the lateral extremities of the hinge, directed and arched obliquely backward with the beak; foramen having near the form of an equilateral triangle, but rather narrowed upward to the apex of the beak, and partly occupied by the cardinal process of the other valve. Interior showing the teeth to be moderately prominent; concavity for the muscular impressions very shallow, small, somewhat bifid anteriorly, and not defined by a very distinct marginal ridge; scars of divaricator muscles apparently narrow, and situated on each side of a shallow mesial depression, which seems to include, far back at its posterior end, those of the very small adductors, merely separated from each other by a hairline; impressions of ventral adductor muscles apparently wider and shorter than those of the divaricators; striæ and fine granules of the interior as in the other valve.

Surface of both valves ornamented by numerous, distinct, radiating striæ, that usually bifurcate about three times between the beak and free margins; posterior lateral striæ so strongly curved that a part of them run out on the hinge line. Numerous, very minute, regularly disposed, concentric lines may also be seen by the aid of a magnifier, most distinctly defined in the furrows between the much larger radiating striæ; while a few distant, sub-imbricating, stronger marks of growth are usually seen in adult shells.

Length of a medium-sized, mature specimen, 0.60 inch; breadth, 0.75 inch; convexity, 0.25 inch.

This species is described in the *Ohio Paleontology*, vol. i., page 109, as *O. emacerata*, and fully illustrated on plate 8, figs. 1 *a* to *d*, and figs. 2 *a* to *g*.

The typical specimens 2 *a* to *g*, are quite common at the quarries in Hamilton, Butler county, associated with *O. ella*, *O. bellula*, *O. fissicosta*, *O. plicatella*, *O. sinuata*, *Glyptocrinus decadactylus*, and other species indicative of a range from 300 to 400 feet above low watermark, at Cincinnati.

It may readily be distinguished from *O. emacerata*, for which it has been mistaken, by the following characters, to wit: It is smaller, striæ not so fine, mesial sinus on the dorsal valve and mesial ridge on the ventral valve more distinct and better defined, greatest convexity of the ventral valve more central; greater difference in the size of the anterior and posterior muscular scars of the dorsal valve, and anterior scars more nearly oval in outline. It has not been found associated with the *O. emacerata*, and, so far as known, has a range commencing about fifty feet above the range of the latter, and extending to near the top of the exposure of the Lower Silurian rocks. The largest specimens that I have seen were found near Oxford, in Butler county, Ohio. It is abundant, and has an extensive range.

Orthis multisecta—(James, 1873).

Shell small, subcircular, plano-convex, or sometimes concavo-convex, hinge line shorter than the greatest breadth of the valves; valves thin.

Dorsal valve nearly flat, or having a concentric depression through the middle; mesial sinus undefined or indistinct; beak small, not incurved; area low at the middle, and narrowing off to nothing at the lateral extremities; foramen very small and filled by the cardinal process. Interior flat; mesial ridge extending to about the middle of the shell, without any well defined termination; scars of posterior pair of adductor muscles a little smaller than the anterior pair, from which they are separated by a very fine line, or, more generally, not distinctly separated; cardinal process very small, conical, obscurely trifid on the posterior side; brachial processes slender, prominent, and directed obliquely forward; surface granular and showing the radiating striæ.

Ventral valve convex, with elevated mesial ridge, greatest convexity just behind the middle; beak arched, projecting slightly; area moderate, narrowing laterally; foramen an equilateral triangle, partly occupied by the cardinal process of the other valve. Interior strongly concave, showing moderately prominent teeth; dental laminæ extend from the base of the teeth forward, gradually becoming more indistinct as they fade away in a circular line to the mesial depression, forming a heart-shaped cavity for the muscular scars; surface granular and showing the radiating striæ.

Surface of both valves ornamented by fine radiating striæ, that increase by bifurcation; lateral striæ curved so that a few of them run out on the hinge line; concentric striæ plainly visible with the aid of a magnifier, and sometimes visible to the unaided eye; imbricating marks of growth usual. Length of an average full grown specimen, 0.50 inch; breadth, 0.58 inch; convexity, 0.20 inch. They vary, however, from one fourth this size to one half larger.

It is abundant at nearly all exposures from low water-mark, at Cincinnati, to 250 feet above; after this, as we ascend the strata, the form which I have called *Orthis Meeki* prevails in its stead. It would be impossible to determine where one form begins and the other ends, as they clearly intermingle, and leave the constantly recurring impression that they are not specifically distinct. Take, however, either young or old specimens from an elevation of 150 feet, and compare them with like specimens in age from an elevation of 400 feet, and the distinction is manifest, both externally and internally. It differs from *O. Meeki*, externally, as follows: It is smaller, more circular, because of the shorter hinge line; dorsal valve flatter and more usually with a concentric indention. It is distinguished from *O. emacerata*, which is associated with it in a limited range, both externally and internally, as will be seen from the description of that species. I have been unable to point out satisfactory differences between this form and that described by Mr. James, as *Orthis Cyclus*, in this Journal, vol. i., page 19, January, 1874, though Mr. James may be correct in the distinguishing characteristics he has designated.

Orthis emacerata—(HALL, 1860).

Shell semi-elliptical, length and width about as 5 to 7; hinge line nearly equaling the width of the shell. Dorsal valve flat, with a slight depression down the center; area extremely narrow. Ventral valve depressed convex, slightly elevated at the beak, which is inclined over the area, but scarcely incurved; an undefined elevation extending from the umbo toward the front, and sometimes quite to the margin of the shell; area narrow, almost linear.

Surface finely striated; striæ bifurcating, curving upward and running out on the hinge line. Interior of the dorsal valve, with two small teeth and a small cardinal process; valves thin.

It is distinguished readily from the *O. testudinaria* by the internal markings of the valves, by the thinner shell and finer external striæ, there being at least 20 more on the margin of shells of equal size. The depression in the center of the dorsal valve and elevation in the center of the ventral valve are less conspicuous, and the hinge line proportionally longer, generally, than in *O. testudinaria.*

[This definition is from 13th Reg. Rep., N. Y., page 121.]

It is found at Columbia avenue and Torrence road, 160 feet above low water-mark. It was found in the excavation of Deercreek tunnel, at the same elevation. It is not abundant, and seems to have a very limited range. Having hunted the quarries at Hamilton, in Butler county, and for other reasons that are elsewhere made apparent, I do not believe that this form is found at that place, or in that horizon. I have never known it to be found over 200 feet above low water-mark, at Cincinnati.

Prof. Meek, in the *Ohio Paleontology*, described a shell as *O. emacerata*, and illustrated it with eleven figures, and gave the localities and position for it at Cincinnati, 250 feet and more above the Ohio, and at Hamilton, in Butler county. Now, while I regard Prof. Meek as one of the best and most careful paleontologists, and have freely copied his labors in this monograph, I am, nevertheless, quite confident that he did not describe or illustrate the *O. emacerata*, and that he did not have the species before him.

To account for this mistake, let us look at the following facts: Prof. Meek's figures, plate 8, figs. 2 *a-g*, are (I believe), Hamilton, Butler county, specimens, and 1 *a-d* are from Cincinnati, or some other place. He was, doubtless, informed, by some mistake, that these were identified here, or known here as *O. emacerata*, and after examining them, and ascertaining that they were distinct from *O. testudinaria*, with expressions of grave doubt he referred them to Hall's species *O. emacerata*, and proceeded to redefine it. And here he made another singular mistake; in his quotation from Prof. Hall's definition, he says: "I am in considerable doubt whether it was this or the following form to which Prof. Hall applied the name *O. emacerata*. His remark, that his type has finer striæ, and the depression in the middle of its dorsal valve usually deeper, and the mesial elevation of the ventral valve more prominent than in the form most generally referred to, *O. testudinaria*, would seem to indicate that he had the following form in view, and regarded that here under consideration as the *O. testudinaria*."

It will be observed that Prof. Hall said just the reverse of what is here ascribed to him. He said: "The depression in the center of the dorsal valve, and elevation in the the center of the ventral valve, are less conspicuous, and the hinge line proportionally longer, generally, than in *O. testudinaria*."

With incorrect information, and through inadvertence, Prof. Meek has well defined and illustrated a form (heretofore generally identified as *O. testudinaria*) as typical of Hall's species *emacerata*, but which I regard as distinct from both, and certainly far removed from the *emacerata*. I have called the form described and pointed out by Prof. Meek, *O. Meeki*, and it matters but little whether it is regarded as a variety of *testudinaria*, or as a distinct species, because it is at least a form that may be generally recognized.

The *O. emacerata* may be farther distinguished, as follows: It is larger than the *O. multisecta*, with which it is associated; its valves are thinner, striæ finer, greatest convexity nearer the beak, and nearer semi-elliptical in form; the muscular impressions on the dorsal valve are larger in proportion to the size of the shell, differ a little in shape, being irregular, sub-trapezoidal in outline, and the cardinal process is more distinctly trifid; the muscular impressions on the ventral valve are wider, and better defined, with proportionally a much stronger indentation on the sides at the line of separation of the scars. It may be further remarked, that there is no graduating of the shells called *multisecta* into this form, so far as observed, though they are abundant in the same rocks, and above and below them.

Orthis lynx—(Von Buch, 1837).

Shell attaining a large size, nearly equivalve, wider than long, with a transversely oval, subquadrate outline, or, in old specimens, often becoming so gibbous as to assume a subglobose form; hinge line either a little less or exceeding the greatest breadth of the shells; cardinal extremities obtusely angular, rectangular, or acutely angular; lateral margins convex, nearly straight or sinuous behind and rounding to the front, which is sinuous, rounded, or somewhat prominent at the middle; beaks and cardinal areas of the two valves nearly equal, the former incurved and approximate, or sometimes contiguous.

Dorsal valve most convex, greatest convexity near the middle, mesial fold rounded, moderately prominent, commencing near the beak, and continuing forward, gradually widening and rounding with the curve of the valve to the front; lateral slopes convex; beak projecting beyond the hinge margin, strongly incurved; cardinal area well developed, nearly as wide as that of the other valve, directed backward, and more or less incurved; foramen broad, triangular, and not closed by the cardinal process. Interior showing cardinal process to be very small, or merely having the character of a low, linear ridge in the rostral cavity; posterior pair of muscular impressions corrugated, and decidedly larger, and more widely separated than the others.

Ventral valve with a mesial sinus corresponding to the fold in the other valve, and terminating at the front in a rather short, somewhat rounded projection, that curves more or less upward into a sinuosity of the same size and form in the margin of the dorsal valve; beak less strongly incurved than that of the other, and slightly more prominent at its apex; cardinal area one fourth to one third higher at the middle than that of the dorsal valve, and narrowing less rapidly toward the lateral extremities; beak incurved, projecting beyond the margin; foramen approaching in form an equilateral triangle. Interior with hinge teeth moderately prominent and trigonal; muscular cavity comparatively small, elongate-oval, sides nearly parallel, scarcely reaching the middle of the valve, well defined by the dental ridges, and sometimes extremely profound.

Surface of each valve ornamented by 16 to 24 strong, more or less angular, radiating plications, of which 3 to 5 occupy the mesial sinus, and 4 to 6 the mesial fold; plications usually simple, but sometimes bifurcate once; lines of growth near the free margins present a zigzag appearance in crossing the plications and furrows; surface sometimes showing under a magnifier minute granules.

Shells regarded as belonging to this species are found at Cincinnati, within 250 feet of low water-mark, and from thence extend throughout the Cincinnati Group. Large specimens are rare until an elevation is reached of about 400 feet, and the earlier forms usually have a length and breadth greater than their convexity. At 425 feet a bed is reached, about ten feet in thickness, containing the largest of specimens; these usually have a convexity about equal to their length.

This bed seems to be 60 or 80 feet thick, back of Maysville, in Kentucky. Specimens vary in size from that of a pea to that of the largest walnut.

Orthis laticosta—(JAMES, 1873).

This form scarcely attains to more than two thirds the bulk of the largest specimens of the *O. lynx*, and is always less gibbous, proportionally wider on the hinge line, with more angular posterior lateral extremities, and even in the largest individuals it is a much thinner shell. It likewise differs in having its mesial sinus wider and much more profound at the front, and its mesial fold more elevated and angular; while its lateral slopes are decidedly more compressed, those on each side of the sinus being always concave, and the margins of the sinus very prominent and angular, which, together with the prominence of the mesial fold, and the greater length of the hinge line, impart a general angularity of appearance not seen in the lynx. In the sinus there are nearly always three plications, the lateral two being smaller than the middle one, or sometimes rudimentary; while occasionally one of them is obsolete, leaving the large one as usual, in the middle, and a smaller one on one side only. The mesial fold has generally four plications (never more), the middle two being usually larger and more prominent than the others, and separated by a larger and deeper furrow. Its lateral slopes have generally only from five to seven large, simple, angular plications on each side of the fold and sinus; these being decidedly larger than on specimens of *lynx* of corresponding size.

Internally the ventral valve differs from the *lynx*, in having the cavity for the muscular scars much less deeply impressed, owing to the fact that the shell did not thicken within, as in that form, as it advanced in age. Interior of dorsal valve shows the same rudimentary cardinal process; while its muscular scars are moderately defined, the posterior pair being corrugated and much larger, as well as more widely separated than the anterior.

Length of a large specimen, 0.86 inch; breadth, 1.40 inches; convexity, 0.88 inch.

Found on the hills back of Cincinnati, from 300 to 400 feet above low water-mark, and at other localities, but the extent of its range is not known. It is moderately abundant.

Orthis dentata—(PANDER).

This form is much smaller than the *O. laticosta* and always proportionally narrower in its transverse diameter. Its hinge line, generally, about equals the greatest breadth of the valves, but may be a little less or a little greater than the breadth. Its lateral slopes are always more abrupt and much less compressed than the *laticosta*, but like that form its mesial sinus is large, and very profound, with angular margins, and its mesial fold strongly elevated. In old individuals the valves become often remarkably gibbous, the convexity exceeding the length and nearly equaling the breadth [the old individuals here referred to in Prof. Meek's description are usually found clustered together, and I believe they are the same defined by Mr. James, as *O. crassa*, in vol. i., page 20, of this Journal, January, 1874]; being much increased by the prominence of the mesial fold, and the elevation of the plications forming the margins of the sinus. It also differs in having but a single, strong plication in the sinus, and only two on the mesial fold. All of the plications are simple, and excepting the occasional rudimentary ones, quite coarse, prominent and angular; the number on each lateral slope being constantly five or six.

Found from 250 feet above low water-mark to the top of the hills, back of Cincinnati, and at other places.

For *Orthis cypha* (James), see vol. i., page 20, of this Journal, January, 1874.

Orthis acutilirata—(Conrad, 1842).

The most common form is much extended on the hinge line, which usually terminates in acutely angular or even mucronate lateral extremities, thus causing the breadth to be sometimes twice, or even three times the length of the valves. Others have the hinge not more than one fifth greater than the length. In all of its variations of proportional length and breadth, it agrees in having three, or very rarely four, simple angular plications in the bottom of the sinus, and four or very rarely five on the mesial fold, which is always rounded, and comparatively little elevated. All of its plications are simple, and smaller, and more numerous than those of the *lynx*, *laticosta*, *dentata* (?), there being on each side of the mesial fold and sinus from 11 to 18, making the entire number from 26 to 40 on each valve. The specimens with extended lateral extremities have the most plications, but only about the same number reach the beaks, as on those less dilated, because they run out on the lateral extensions on the hinge line.

This form becomes quite gibbous with age, the gibbosity being, generally, most obvious in the specimens least extended on the hinge line, some of those with the most produced lateral extremities having the middle portions of the valves quite as convex as any of the others of the same anterio-posterior dimensions. In these the lateral slopes are very concave, and the anterio-lateral margins sinuous and strongly converging toward the front. The mesial sinus is well defined, and widens and deepens rather rapidly forward; and as the mesial fold is proportionally less elevated, the front is often thus caused to be distinctly sinuous in the middle.

Old specimens become quite thickened within, and consequently have the cavity for the muscular attachments in the ventral valve very deep, and similar to the *lynx*. The surface granulations are usually very beautifully preserved.

Found at Madison, Richmond, Clarksville, and generally, wherever the upper 200 feet of the Cincinnati Group is exposed. I have never known it to be found at an elevation of less than 600 feet.

Orthis borealis—(Billings, 1859).

Shell rather under medium size, transversely oval-subquadrate, or truncato sub-oval, the length and breath varying, with relation to each other, from as 9 to 11 to 11 to 12; both valves convex; hinge line shorter than the greatest breadth of the valves (which is usually a little in advance of the middle), meeting the lateral margins at more or less obtuse angles; lateral margins rounding to the front, which is rather broadly rounded, or possibly sometimes faintly sinuous at the middle.

Dorsal valve sometimes slightly more convex than the other, its most prominent part being near, or a little behind the middle, usually sloping rather more distinctly to the lateral margins than toward the front, where there is generally a broad, very low, undefined prominence, or mesial elevation; beak moderately prominent and arched, but not strongly incurved; area about half the height of that of the other valve, directed backward and more or less arched. Interior unknown.

Ventral valve most convex near the umbo, and sloping sometimes rather abruptly toward the posterior lateral angles, while the anterior central region is depressed, so as to form a broad, very shallow mesial sinus, sometimes extending backward nearly or quite to the middle; beak more prominent than that of the other valve, rather abruptly pointed, inclined backward and moderately arched; area broad-triangular, well defined, and tapering to the lateral extremities of the hinge, inclined and a little arched backward with the beak; foramen rather narrow, so slightly higher than its breadth at the hinge. Interior unknown.

Surface of both valves ornamented by distinct, rather prominent, radiating ribs, about forty of which may be counted on each valve of a medium-sized specimen; the furrows between the ribs equaling the breadth of the ribs themselves; larger individuals sometimes having a few of the ribs bifurcating once, and an occasional smaller one intercalated between two of the larger, so as to increase the whole number at the free margins to about fifty. Concentric striæ nearly or quite obsolete; but in old specimens, one or more sub-imbricating marks of growth may sometimes be seen near the free margins.

Breadth of a large specimen, 0.74 inch; length, 0.64 inch; convexity, 0.33 inch.

Found at Frankfort, Kentucky, and at other places in the lower part of the Cincinnati Group; but rare.

Orthis plicatella—(Hall, 1847).

Broadly semi-oval, nearly equivalve, length and breath about as 3 to 4; surface marked by simple, strong, angular, radiating plications, about 20 to 28 on each valve, crossed by simple, elevated, concentric lines, which are more distinct in the depressions between the costæ, and often obscure or obsolete upon their exposed surfaces; valves nearly equally convex, without sensible depression or elevation on either one, meeting at the edges in a straight line; cardinal line not extending beyond the width of the shell; area narrow; dorsal foramen extending to the beak.

It is found at Cincinnati, from about 300 feet above low water-mark, to the top of the hills. Its range, so far as known, is from 300 to 500 feet above low water-mark, and it is not rare where the rocks of this horizon are well exposed. It is usually found where the *O. fissicosta* abound.

Orthis fissicosta—(Hall, 1847).

Semi-oval, with the cardinal line somewhat less than the width of the shell; area narrow; foramen narrow, triangular, reaching to the apex; dorsal valve moderately convex, with the beak extending and slightly incurved; ventral valve moderately convex in the middle and depressed at the sides; surface marked by angular costæ, which become bifid and trifid on the center or toward the margin of the shell; number of costæ about 19 or 20.

Found at Cincinnati, from 300 to 400 feet above low water-mark, and though Prof. Hall obtained, as he says, "but a single specimen near Cincinnati, showing that the shell is comparatively rare," yet it would not be extraordinary for a collector to pick up a hundred specimens in a day, at an elevation of about 340 feet, back of Cincinnati. It is found at Hamilton, Butler county, near Lawrenceburg, Indiana, and in Warren and Clermont counties, showing that it is persistent in its range, which is probably confined between 300 and 500 feet above low water. It is rather more abundant than its associate, *O. plicatella*, from which it may readily be distinguished by its divided costæ.

Orthis triplicatella—(Meek, 1873).

This form has some resemblance to *fissicosta*, and some to *plicatella*. Prof. Meek says, it has the "same form, coarse costæ, and general appearance of *O. plicatella*, but differing in attaining a larger size, and in having the area of the ventral valve *decidedly* lower, and the beak of the same more incurved than in any well characterized specimen of that form. It also differs in having the costæ much more widely separated by deeper furrows, and each giving off a small lateral division from near the middle of the valves; the main ones, however, continuing larger and more prominent to the free margins, thus forming bundles of three ribs, with a wide, deep depression between." The internal characters still remain unknown, and the only specimens I have seen are those I sent to the Smithsonian, for Prof. Meek's study. I believe, however, that it is a distinct species for one reason more than those urged by Prof. Meek. Large *fissicosta* and *plicatella* have thick, firm shells, while these specimens appeared to have rather light, thin shells. It may be only a variety of *fissicosta*.

Largest specimen—breadth, 1.04 inch; length, 0.70 inch; convexity, 0.40 inch.

Found up lime-kiln hollow, in Cincinnati, at an elevation of about 350 feet above low water-mark, associated with *fissicosta*.

Orthis bellula—(James, 1873).

Shell very small, longitudinally semi-oval, or transversely sub-oval, moderately gibbous, sub-equivalve; breadth always greater than the length; hinge line a little less than the greatest breadth of the valves; posterior lateral extremities abruptly rounded, or sub-angular; lateral margins rounding to the front, which is broadly semi-elliptic in outline, or sometimes a little straightened, or even very faintly sinuous at the middle. Interior unknown.

Dorsal valve less convex than the other, with usually a very slight, scarcely perceptible mesial depression near the umbo, that rarely, if ever, extends forward to the middle; beak small, projecting slightly beyond the edge of the area, and merely a little arched; area of comparatively moderate height, flat, or somewhat arched, and inclined more or less obliquely backward and upward; foramen forming a nearly equilateral triangle.

Ventral valve most convex near the umbo, and perhaps always showing a very shallow, broad, undefined mesial sinuosity at the front; beak moderately prominent, pointed, inclined backward and a little arched, but not incurved; area comparatively rather high, or from twice to three times the height of that of the other valve, well defined, a little arched, and inclined obliquely backward and downward; foramen narrow, triangular, and extending to the point of the beak.

Surface of both valves ornamented by very fine radiating striæ, most of which bifurcate two or tree times between the beaks and free margins; the lateral ones being moderately arched.

Length of a medium sized specimen, 0.23 inch; breadth, 0.28 inch; convexity, 0.13 inch.

Found associated with *O. plicatella* and *O. fissicosta*, on the hills back of Cincinnati, and at the quarries at Hamilton, in Butler county, at an elevation of about 350 feet above low water-mark. It is a rare fossil.

Orthis (?) *ella*—(Hall, 1860).

Shell small, ovate; valves nearly equally convex; hinge line extremely short, being scarcely more and sometimes less than one third the width of the shell, and scarcely affecting the contour of the cardinal margin, which slopes from the beak of the ventral to the lateral margins a little above the middle of the valve. Dorsal valve gibbous, sub-circular; the beak extending a little above the hinge line, and the area extremely short. Ventral valve broadly ovate, sloping from the beak; beak produced beyond the line of the opposite valve, and pointed, not incurved; area twice as long as high; foramen narrow and extending to the apex of the beak, and sometimes truncating the extremity.

Surface marked by from fifteen to twenty simple, abruptly rounded or sub-angular plications.

The short hinge line and area, and the produced beak of the ventral valve, are characteristic features. They differ very much in size and in the number of striæ. Length sometimes a little greater than the breadth, and breadth sometimes a little greater than the length.

Length varies from one eighth to half an inch, though usually about one-fourth of an inch.

It is found at the quarries surrounding Cincinnati, at an elevation of 340 to 400 feet. It is found at Hamilton, Butler county, at a corresponding elevation. It is not a common fossil.

For *Orthis* (?) *morrowensis* (James) see vol. 1, p. 21, of this Journal, January, 1874.

Orthis costata—(Hall, 1845).

Semi-circular or semi-oval; surface marked by about twelve strong ribs; area well defined, proportionally large; hinge line scarcely equal to the width of the shell, which is about one fifteenth of an inch.

This is a very minute fossil, and known to me only from the top of the hill at Mount Auburn, in Cincinnati, at an elevation of about 400 feet above low water-mark. It is possible that it is the young of *O. plicatella*.

Orthis Jamesi—(Hall).

Shell transversely semi-elliptical; hinge line equaling, or a little greater than the width of the shell below; the length a little more than half the width, and sometimes nearly two thirds. Cardinal extremities compressed, and usually truncate or rounded. Dorsal valve convex, becoming gibbous, with a shallow, often scarcely defined sinuosity in the middle; hinge line slightly rising toward the beak, which is not incurved; area narrow, but distinctly defined; foramen broad, and showing a narrow process, which rises as high as the plane of the area. Ventral valve much elevated toward the beak; the sides somewhat flattened, and the middle sometimes a little depressed toward the front; the beak slightly arcuate, and the wide area nearly flat and moderately inclined backward; foramen large, and extending to the apex.

Surface marked by twenty to twenty-four simple, strongly rounded, slightly arching, primary striæ, which, by intercalations of secondary striæ, are often increased to twice that number on the margin.

Often the striæ are simple throughout, and, when well preserved, are always marked by fine, thread-like, concentric striæ, and toward the margin a few lamellæ of growth.

This species, in general form, resembles *O. plicatella*, but the area is much larger, and extends to the salient cardinal extremities; while in that species the extremities are usually rounded, and the shell is a little rounded below.

Found at Cincinnati, at an elevation of about 400 feet.

Orthis clytie—(Hall).

Shell larger than medium size, semi-elliptical, the length about as 4 to 5, or as 7 to 9, plano-convex or concavo-convex; hinge line less than the greatest width of the shell; cardinal extremities rounded. Dorsal valve flat or concave, with a longitudinal depression along the center; cardinal area linear, not incurved; ventral valve moderately convex; sometimes more elevated or subangular along the middle, toward the beak; area narrow, longitudinally striated, and extending a little more than two thirds of the shell; foramen wide; beak scarcely incurved. Muscular impression deeply divided; in the middle of the inner division of each lobe, more deeply impressed, and extending two thirds of the length of the shell from the beak; the outer portions flabellate, and margined by an elevated ridge; the whole interior surface granulose, and the visceral area margined by a thickened elevation, which becomes, in old shells, a defined ridge. The striæ are shown along the inner margin.

In the dorsal valve the inner surface is finely striato-granulose, and outside of the submarginal ridge the striæ are stronger. The muscular impression is comparatively small, distinctly circumscribed, with central ridge thin, prominent cardinal process, and strongly defined dental fossets and corresponding crural processes.

The surface is finely and somewhat evenly striated; the striæ on the ventral valve often more prominent than those on the dorsal valve.

This is a very well marked and distinct species, which in the deeply bifid muscular impression differs from any other species in this group of strata; while in other features it is readily distinguished.

Found at Paris, Kentucky.

Orthis occidentalis—(Hall, 1847).

Shell attaining a moderately large size, wider than long, varying from transversely subquadrate to semi-oval, becoming quite gibbous with age; hinge line exceeding, about equaling, or sometimes a little less than the breadth of the valve at any part farther forward, lateral extremities moderately compressed, varying from rather acutely to more or less obtusely angular; lateral margins often a little sinuous behind, but sometimes straight or convex in outline, but rounding to the front, which is nearly always a little sinuous, and sometimes rather decidedly so in the middle.

Dorsal valve more convex than the other, especially in the large adult examples; its greatest convexity being, generally, a little behind the middle, on each side of a shallow, undefined mesial sinus, generally extending from the front to the umbonal region, but sometimes nearly or quite obsolete, or only represented by a slight flattening along the middle; swell of the umbo comparatively prominent, and often projecting backward further than the beak of the other valve; beak rather strongly incurved; area of moderate height in the middle, but sloping to the lateral extremities, sharp along the margin, and more or less strongly incurved, foramen broad, triangular, and not closed by the cardinal process. Interior with scars of the adductor muscles situated on each side of a low mesial ridge, which is narrower between the anterior than the posterior pair, which latter are placed far back under the brachial processes, and rather strongly striated, but without well defined margins; anterior pair somewhat trigonal, and usually each separated from the posterior by an obscure transverse ridge, but without well defined anterior margins; cardinal process merely presenting the appearance of a compressed or sharp ridge, much lower than the surface of the cardinal area; sockets distinct; brachial processes directed forward, and more or less laterally, usually sharp on their inner under edges; vascular scars unknown.

Ventral valve most convex at or near the apex of the beak, from near which it slopes more rapidly to the front and lateral margins than to the anterior lateral, the anterior region being impressed so as to form a broad, more or less deep, undefined mesial sinus, that dies out before reaching the umbo; beak rather elevated, but not projecting backward, abruptly pointed very nearly straight, or sometimes slightly arched at the point; cardinal area rather high at the beak, but sloping to the lateral extremities, flat or slightly arched, and usually standing nearly at right angles to the plane of the valve; foramen generally higher than its breadth at the hinge line, and extending to the apex of the beak. Interior showing the cardinal margin to be prominent and sharp, and the hinge teeth well developed; cavity for the reception of the muscular scars deep, nearly or quite reaching the middle of the valve, obcordate in form, and bounded by a prominent ridge, continued forward from the bases of the hinge teeth, and curved a little backward at the central point of the front, where they meet impressions of the divaricator muscles (cardinal of some) deep; while those of the adjustors are so small, and pushed so far aside, as to occupy the sides of the dental plates, and thus to be out of sight in a direct view; those left by the adductors are narrow, elongated, and situated on each side of a mesial ridge, that is divided along the middle by so wide and distinct a furrow as to appear almost like two linear ridges; transversely striated cavity within the beak very small, and broad triangular, free margin crenate within, while the surface between these and the deeply impressed muscular cavity is usually smooth, or sometimes very minutely and obscurely corrugated; vascular markings unknown.

Surface of both valves ornamented by distinct, rather prominent, radiating striæ, which on the dorsal valve nearly always increase by intercalation, and curved gradually outward on the posterior lateral regions; while on the ventral valve they generally increase by bifurcation, and are nearly straight on all parts. A few distant imbricating marks of growth are also usually seen around the free margins of adult examples, while well preserved specimens show minute but not crowded, prominent, concentric lines crossing the much larger radiating striæ, and the furrows between them.

It is found from about 300 feet above low water-mark, at Cincinnati, to the Upper Silurian rocks; becoming most abundant in the last 100 feet of the upper part of the Cincinnati Group.

Orthis sinuata—(Hall, 1847).

Semi-oval, with a sinus in front; cardinal line scarcely equal to the width of the shell; dorsal area large, triangular; foramen triangular, reaching to the beak, the upper margins sloping rather abruptly from the beak; ventral area narrow, linear; foramen broad, triangular, with a distinct medial tooth, which reaches as high as the area; dorsal valve convex, its greatest elevation at the point of the beak, which is acute; a depression along the center, which becomes a sinus in older shells; ventral valve regularly convex in young specimens, gibbous, somewhat emarginate and elevated in front in older specimens; surface marked by strong, regular rounded striæ, which bifurcate in a nearly uniform manner about half way to the base; striæ crossed by elevated, subimbricating, concentric lines. A few imbricating lines of growth are distinct toward the margin of the older shells.

It is distinguished from the *O. occidentalis* by the stronger and more prominent striæ, which more regularly bifurcate. The beak of the dorsal valve is more elevated and acute, giving a greater height to the dorsal area. The ventral valve is about equally convex or gibbous, but it never exhibits any depression along the center. The depression or sinus in the dorsal valve is usually more abrupt, deeper, and often accompanied by a corresponding elevation on the ventral valve, which does not occur in the *O. occidentalis.* The young shells are more gibbous and have the beak of the dorsal valve more elevated and acute.

It is first found in the hills back of Cincinnati, at an elevation of about 320 feet, and continues to the top of the hills. It is found at Versailles, and Weisberg, Indiana, in Butler, Warren, and Clermont counties, Ohio, and generally wherever the rocks are well exposed, from an elevation of 320 feet, at Cincinnati, to the top of the rocks of the Cincinnati Group. Though good specimens can hardly be said to be abundant.

Orthis retrorsa—(SALTER, 1858).

Shell attaining a large size, varying from transversely suboval to truncato-suboval, or subquadrate, the length being about four fifths its breadth; hinge line shorter than the greatest breadth of the valves, or about equaling their length, with its lateral extremities abruptly rounded or very obtusely subangular; lateral margins more or less convex in outline, and rounding to the front, which is either regularly rounded or somewhat straightened along the middle; valves decidedly unequal, or concavo-convex.

Dorsal valve evenly and sometimes rather distinctly convex, the most prominent part being near, or a little behind the middle, with the anterior and lateral slopes, particularly the anterior, more gradual than the posterior; umbonal convexity projecting a little beyond the hinge; beak incurved; area of moderate height, but with its sharp margins sloping off to nothing near the extremities of the hinge, more or less strongly incurved, so as sometimes to stand at right angles to the plane of the valves; foramen broad triangular. Interior unknown.

Ventral valve convex at the point of the beak, and thence sloping toward the lateral and anterior margins; the anterior central, and sometimes the lateral regions, being more or less concave; beak obtuse, or abruptly pointed, and strongly inclined forward; cardinal area broad, triangular, well defined, flat, and so distinctly inclined forward as to place the apex of the beak some distance in front of the hinge margin; foramen narrow-triangular, being often a little higher than wide, and extending to the apex of the beak.

Interior with muscular cavity rather deep, distinctly quadrangular, scarcely reaching the middle of the valve, and sharply defined by a raised margin, which is perfectly straight and uninterrupted across the front; while its lateral margins are each waved a little outward, along the middle, to make room, as it were, for the scars of the ventral adjustor muscles, which are moderately distinct from those of the longer triangular divaricators; scars of the adductor muscles well defined, and occupying a narrow, subcordate depression, which tapers gradually forward to an acute extremity between the anterior ends of the divaricator scars. Hinge teeth apparently rather small and weak. Vascular markings consisting of two principal trunks, starting from the anterior lateral angles of the muscular cavity, and each immediately dividing so as to send one main branch obliquely outward and backward, with more or less subdivisions, and another forward with an inward curve, and also giving off more or less subdivisions on the anterior lateral side.

Surface ornamented by rather coarse, rounded, radiating striæ, some of which, on the ventral valve, are entirely simple, and others bifurcate once or twice; while on the dorsal, they increase in number by the intercalation of shorter ones between the longer; there being, on a moderate-sized adult shell, about three series of the intercalated ones, the longest of which nearly reach the beak, and soon become as large as the largest, and between these there are a few very short, small ones, near the free margins, and a few others of intermediate length and thickness. A few rather distinct, imbricating marks of growth are usually seen near the free margins of adult specimens; while under a magnifier, minute concentric lines may be seen crossing the striæ and interspaces, and on protected parts of the surface, a strong magnifier also shows very minute asperities, regularly arranged, and having the appearance of minute, hollow, spine-bases, that sometimes leave minute pits when entirely worn off.

Breadth of a moderately large specimen, 1.17 inches; length, 0.95 inch; convexity, 0.47 inch.

Found at an elevation of about 500 feet, in the Cincinnati Group, near Oxford, and near Morrow, Ohio. It is a rare species.

Orthis subquadrata—(Hall, 1847).

Shell attaining about a medium size, rather distinctly resupinate, somewhat wider than long, subquadrate in outline; moderately convex; cardinal margin shorter than the breadth of the valves, and rounding abruptly at the extremities into the lateral margins, which round and converge forward; front a little sinuous or straightened at the middle.

Dorsal valve more convex than the other, its most prominent part being near the middle; mesial sinus small, and rather shallow, sometimes continued back nearly to the umbo, or in other instances scarcely more than reaching the middle; beak very short, or little distinct from the edge of the area, and more or less arched; area narrow, directed obliquely backward and downward. Interior with scars of the adductor muscles moderately distinct, the posterior pair being situated close back under the brachial processes, one on each side of a well defined rounded ridge, that becomes suddenly smaller between the anterior pair; cardinal process rhombic subconical, moderately prominent, and having its posterior sides marked by deeply impressed, divaricating striæ; sockets well defined; brachial processes rather strong, and directed obliquely forward and laterally, internal surface, excepting the radiately striated front and lateral margins, nearly smooth.

Ventral valve a little convex at the umbo and flat, or slightly concave, between the umbo and the front and lateral margins, but sometimes having a low, very obscure, mesial elevation toward the front; beak small, and very short, or scarcely equaling that of the other valve, arched at the apex, but not strongly incurved; area about twice as high as that of the other valve, well defined, tapering rather rapidly toward the lateral extremities, arched with the beak, and directed backward and downward at decidedly less than a right angle to that of the other valve; foramen broad, triangular and partly occupied by the cardinal process of the other valve. Interior with muscular scars, occupying a rather deep, bilobate impression, extending nearly or quite to the middle of the valve, and usually defined by a low ridge most distinct on each side; scars of adductor muscles small, separated by a mere trace of raised line; those of the divaricator muscles of moderate size longitudinally striated, and having their narrowed ends extending backward, nearly to a small triangular, transversely striated space, occupying the interior of the beak; those of the ventral adjustor muscles smaller and shorter than the divaricators, and situated nearly under the hinge teeth, which are moderately prominent, subtrigonal and oblique; vascular markings with their lateral divisions curving up backward, and sending off several branches, while the other divisions extend forward and bifurcate so as to occupy the anterior region; anterior and lateral margins crenate within by very short striæ.

Surface of both valves ornamented by moderately stout, radiating striæ, the posterior lateral of which curve so strongly that a few of them run out on the cardinal edge before reaching the lateral margins; striæ of ventral valve nearly always increasing by bifurcation (some of them dividing two or three times); while those on the dorsal valve generally increase by the intercalation of shorter ones, between the longer. A few distinct subimbricating marks of growth are sometimes seen toward the front and lateral margins; while on perfectly preserved specimens the radiating striæ may sometimes be seen to be roughened by minute, elevated, concentric lines, that are more or less interrupted in crossing some of the striæ.

Length of a well developed specimen, 0.96 inch; breadth, 1.30 inches; convexity, 0.43 inch.

Found at Madison, Versailles, Weisburg, Richmond, Oxford, Freeport, Clarksville, and generally wherever the rocks are exposed within about 200 feet of the top of the Cincinnati Group. Good specimens are not, however, very common at any locality,

Orthis insculpta—(Hall, 1847).

Shell generally rather under medium size, wider than long, subquadrate, or transversely truncato-suboval; hinge line nearly always a little less than the greatest breadth of the valves and meeting the lateral margins at an angle of usually more than ninety degrees; lateral margins generally moderately convex in outline, at or near the middle, and rounding regularly to the front, which is nearly always a little sinuous in the middle; valves moderately and nearly equally convex.

Dorsal valve with its greatest convexity usually a little behind the middle, on each side of a narrow, but moderately deep mesial sinus, that extends from the beak to the front; posterior lateral region distinctly compressed; beak but little prominent, and more or less incurved; area moderately developed, narrowing rather rapidly to the lateral extremities, directed backward and more or less strongly arched, foramen broad, triangular, and partly occupied by the cardinal process, which usually projects slightly beyond the surface of the area and is laterally compressed. Interior showing the brachial processes to be rather prominent and diverging, and the sockets for the reception of the teeth of the other valve distinct; scars of the adductor muscles (occlusors of some) situated on each side of a strong, prominent mesial ridge, behind the middle of the valve, those of the posterior pair being very narrow anterio-posteriorly, and placed back directly under the brachial processes, nearly out of sight in a direct view, while the anterior pair are larger, oval in form, and extend forward nearly to the middle of the valve; vascular markings consisting of two principal lateral trunks, that extend outward and forward from the anterior adductor scars, but immediately bifurcate, sending each a main division backward and outward, and another forward, each with subordinate branches, while between these principal trunks there are two pairs of smaller ones and traces of a few other still smaller, all directed forward.

Ventral valve about as convex as the other, but having its most gibbous part further back, near the umbo, from which point its surface slopes off regularly to the front and lateral margins, without any distinct mesial elevation or depression; beak moderately prominent or projecting backward more or less beyond that of the other valve, and somewhat arched but not properly incurved; area two or three times as high as that of the other valve, near the beak, and sloping off rather rapidly to the lateral extremities, directed obliquely backward and downward, and a little arched with the beak; foramen usually higher than wide. Interior showing hinge teeth to be prominent and subtrigonal; cavity for the reception of the muscular impressions scarcely extending forward to the middle of the valve, tapering a little toward the front, where it is more or less emarginate in the middle, moderately well defined by a rather obscure, marginal ridge, and divided within longitudinally by a low double ridge, that usually extends forward beyond the muscular cavity, where it suddenly contracts to a very narrow, obscure, single ridge, that again expands or bifurcates farther forward; scars of the divaricator and adjustor muscles not very distinctly separated, and those of the adductors not clearly seen in the specimens examined; ovarian areas comparatively rather large, and each occupied by a number of raised linear, rather distant, and sometimes bifurcating ridges or lines, that radiate forward and laterally.

Surface of both valves ornamented by distinct radiating striæ, that increase both by division and intercalation, and are crossed by much smaller, regular, distinctly defined, imbricating, concentric marks, that are more prominent between than upon the radiating striæ, and present a zigzag appearance, by being deflected backward on the striæ and forward on the depression between them; a few much shorter imbricating marks of growth are also usually seen near the free margins of adult specimens.

Length of a mature specimen, 0.60 inch; breadth, 0.78 inch; convexity, 0.35 inch.

Found about 100 feet below the Upper Silurian rocks, at Weisburg, Clarksville, and other localities. At Weisburg, it seems to be confined to strata about three feet in thickness. Good specimens are rare, but valves are more abundant.

Genus *Hemipronites* (Pander, 1830), as redefined by Prof. Meek.

Shell varying from truncato-orbicular to semi-circular, or orbicular subquadrate, more or less convex, the inequality of the valves varying greatly with the species; surface marked with radiating, generally straight striæ, and sometimes with rounded, radiating plications. Hinge usually shorter than the greatest breadth of the valves; provided in the ventral or larger valve with two teeth, situated one on each side of the mesial fissure, and fitting into corresponding sockets in the other valve. Structure probably always impunctate.

Ventral valve with its beak more prominent than that of the dorsal, often bent or twisted, but not regularly incurved; area generally high, sometimes extremely so, its mesial fissure always closed, in adult shells, by a convex pseudo-deltidium. Hinge teeth supported within by two dental plates, which converge under the area toward the beak. Scars of cardinal and adductor muscles occupying about one third to one half the length of the valve (between the beak and the middle) and forming two elongated, oval impressions, more or less deeply excavated, one on each side of a mesial ridge or septum.

Dorsal valve generally with its beak compressed and projecting little beyond the cardinal margin; area usually very narrow or rudimentary. Cardinal process large, prominent, and bifid; either slightly convex or concave on the inner side, with each division more or less grooved or emarginate at the extremity of the outer side; on each side of, and connecting with this, are the well developed socket plates. At the bottom of the valve the quadruple scars of adductor muscles occupy about one third the length of the valve, being arranged in pairs on each side of a short mesial ridge.

This genus occupies a place in animal development between the genera *Strophomena* and *Orthis*, and is supposed to include *filitexta, subtenta, planumbona planoconvexo, nutans, Hallie, etc.*

It is here to be observed, that Prof. Davidson and other authors on *brachiopoda* entirely ignore the name *Hemipronites*, because, as I presume, it was not properly defined by Pander, and substitute for it *Streptorhynchus* (twisted beak), proposed and defined by Prof. King, in 1850. The following are the characters of the genus *Streptorhynchus*, as redefined by Prof. Davidson:

"Shell inequivalve, convex or concavo-convex, externally striated. The smaller valve is semi-circular, the larger or ventral one possessing a prolonged and oftentimes bent or twisted beak; hinge line rather shorter than the width of the shell. The area in the larger valve is triangular, with a fissure covered by a convex pseudo-deltidium. A small, narrow, rudimentary area exists, likewise, in the smaller valve. No foramen is observable, but the cardinal process is at times seen partially extending under the deltidium.

"In the interior of the larger or ventral valve a strong hinge tooth is situated on either side at the base of the fissure, supported by a dental ridge or plate; these diminish in size as they converge under the area toward the extremity of the beak. At the bottom of the valve, under the beak, and extending a little beyond, are the impressions left by the cardinal and adductor muscles, which occupy about one third of the length of the valve; they form two elongated oval scars, more or less deeply excavated, and separated by a rather wide mesial ridge. In the interior of the smaller or dorsal valve the cardinal process is largely developed, being composed of two testaceous projections, which are either slightly convex or concave on the side facing the interior, but grooved or bidentated toward the extremity of their outward surface; the socket plates are large and partly united to the lower portion of the cardinal process. Under these, on the bottom of the valve, are seen the quadruple impressions left by the adductor, which occupy more than a third of the length of the valve, and are arranged in pairs, divided by a short, rounded mesial ridge."

The species found in the Cincinnati exposure of the Lower Silurian belong to a sub-group having the following characters:

Beak of neither valve prolonged, but, on the contrary, projecting so slightly, as to be scarcely distinct from the edge of the area; hinge line usually as long or longer than the width of the shell further forward; lateral extremities usually rectangular or terminating in regular points more or less deflected; beak of ventral valve perforated.

Interior of dorsal valve with bifid cardinal process; more or less distinct mesial ridge, and longitudinal furrows; socket ridges short and oblique. Interior of ventral valve with hinge teeth, divergent, oblique, and moderately developed; dental ridges encircling or nearly encircling a more or less saucer-shaped cavity, in which are situated the muscular scars, separated by a more or less defined mesial ridge.

I have followed Prof. Meek in using *Hemipronites* instead of *Streptorhynchus*, though in the *Ohio Paleontology* he has, as I think, erroneously called it a sub-genus. Prof. Hall uses the name *Streptorhynchus* for all these shells.

Hemipronites filitexta—(Hall, 1847).

Shell semi-oval, length usually less than the breath; hinge line generally greater than the breadth at any point farther forward; lateral extremities usually somewhat acutely angular, and deflected; lateral margins a little sinuous posteriorly, and rounding to the semi-circular front.

Dorsal valve flat in the umbonal region, and evenly convex in the anterior central and lateral portions, and curving downward, around the front and lateral margins; area narrow, or nearly linear, and directed obliquely backward and upward; beak not distinct from the margin of the area.

Interior showing cardinal process short and divided into two low diverging parts, directed obliquely forward and outward, and flattened on their posterior faces; socket ridges longer and stronger than in *planumbona;* mesial ridge low and terminating before it reaches the middle of the valve. On each side of the mesial ridge and between it and the socket ridges three parallel ridges start forward; those nearest the socket ridges are low and short; those adjoining the mesial ridge become stronger as the mesial ridge fades away, and form coarse strong ridges as they pass the middle of the valve, and do not terminate until they have nearly crossed the valve; the other two ridges are not quite so large, and are a little shorter than the last. Other light lines and granulations in the cavity of the shell do not preserve uniformity of appearance in different specimens.

Ventral valve nearly flat, or slightly convex in the umbonal region, and broadly and deeply concave in all the central and anterior central parts, but curving upward around the front and lateral margins nearly parallel to the free margins of the other valve; cardinal area of moderate height, extending the whole length of the hinge, but sloping rather distinctly from the beaks laterally, flat and directed nearly at right angles to that of the other valve; beak very small, and only projecting slightly beyond the margin of the area; foramen closed by the usual convex pseudo-delitidium, which is deeply sinuous on its inner margin, for the reception of the cardinal process of the other valve. Interior with cardinal edge but slightly prominent; hinge teeth subtrigonal, oblique, and but moderately developed; dental ridges prominent, strong, and encircling a rather large, deep, saucer-shaped cavity, one third to one half the length of the valve, and marked within by an obscure central ridge, and on each side of this by rather strong radiating furrows; anterior and lateral margins a little thickened within, and divided by the crossing, apparently, of the vascular markings into short obscure ridges; entire internal surface sometimes showing, under a magnifier, a very minute, obscurely granular appearance.

Surface of both valves ornamented by numerous fine, subequal, crowded and rounded striæ, that increase by intercalation. Concentric striæ may be seen with the aid of a magnifier. A number of strong plications or wrinkles extend from the edge of the area on each side of the beak on each valve a short distance at right angles to the cardinal line, or slope a little inwardly.

Length of a large specimen, $1\frac{1}{2}$ inches; breadth, $1\frac{3}{4}$ inches; convexity, a little over one third of an inch. But specimens vary in their proportions and differ widely in size. One specimen, four fifths of an inch in length, one inch in width, has a convexity of one fifth of an inch.

This species, though widely dispersed, has a very limited range (at about 700 feet above low water-mark) in the Cincinnati Group, and is not particularly abundant at any locality. Richmond, Indiana, is about as good as any locality for collecting it.

Streptorhynchus vetusta (James) vol. 1, p. 241, Cin. Quar. Jour. of Sci., July, 1874, seems to be very closely related to this species.

Hemipronites planumbona—(Hall, 1847).

Shell medium size, concavo-convex, semi-oval; hinge line generally longer than the breadth of the shell forward; lateral extremities more or less compressed and deflected; lateral margins contracted posteriorly and rounded to the front, which forms a regular semi-circular curve.

Dorsal valve flat in the umbonal region, and rather strongly and evenly convex in the central and anterior regions, from which it rounds off abruptly to the front and lateral margins; beak not distinct from the edge of the sublinear area. Interior showing small cardinal process, depressed, divided to its base into two diverging tooth-like parts, flattened on their posterior faces and directed obliquely forward and outward; socket ridges short and oblique; mesial ridge low, extending but a little distance forward, and the space between it and the socket ridge, on each side, is occupied by a moderately distinct muscular scar.

Ventral valve broadly and rather deeply concave in the central and anterior regions, and slightly convex at the beak, which is very small, scarcely projecting beyond the edge of the area and usually minutely perforated; area moderately high, extending the whole length of the hinge; flattened and inclined a little backward; foramen closed by a prominent, rounded, pseudo-deltidium, that is transversely striated, and rather broadly sinuous in its inner edge for the reception of the cardinal process of the other valve. Interior showing hinge teeth well developed, trigonal and striated on their posterior sides; dental laminæ extend forward from their inner bases, so as to nearly encircle the saucer-shaped depression for the muscular scars, which is sometimes divided by a small, linear mesial ridge; cardinal margin prominent and sharp within on each side of the hinge teeth; anterior and lateral regions more or less thickened within, and roughened by the crossing of the vascular markings, which are scarcely visible on any part within this zone.

Surface of both valves ornamented by numerous fine, closely crowded radiating striæ, sometimes alternately larger and smaller, the smaller ones being shorter and intercalated. Concentric lines are sometimes visible with the aid of a magnifier. Some specimens show imbricating marks of growth near the free margins.

Length of a medium specimen, three fourths of an inch; breadth, an inch; and convexity, one fourth of an inch.

Found at Versailles, Weisburg, Richmond, Freeport, Clarksville, and other localities in the upper part of the Cincinnati Group. Its range seems to be confined to the rocks from 600 to 800 feet above low water-mark. It is common within this range.

Hemipronites subtenta—(Conrad, 1847).

This species so closely resembles *H. planumbona* that one might be classed as a variety of the other. The chief differences are as follows:

The striæ ornamenting the valves are possibly coarser on the *subtenta* than on the *planumbona*, and a few wrinkles on the valves directed inward and backward from the edge of the area on each side of the beak characterize the *subtenta*.

Its range is the same as that of *planumbona* and it is specially abundant at Richmond, Indiana.

Strophomena plicata (James) of the *Ohio Paleontology* is a synonym for this variety or species.

Hemipronites nutans—(James, 1871).

Shell subtrigonal, strongly concavo-convex, comparatively thick and strong; hinge about equaling the breadth of the valves.

Dorsal valve remarkably convex, with a prominent anterior region, somewhat like a mesial ridge near the margin; umbonal region flattened; beak not distinct from the edge of the area; area sublinear and directed backward. Interior with short bifid cardinal process; sockets deep, subtrigonal and very oblique; socket-ridges prominent, thin, and continued obliquely forward and outward with an inward curve, so as to form the lateral margins of the muscular impressions, which are well defined, rather deep, strongly striated, and separated by a short, mesial ridge coming from the base of the cardinal process; while near the middle of the anterior edge of each there is sometimes an oblique prominence; central region, in front of the muscular impressions, showing four obscure parallel ridges running directly forward, and separated from each other by three shallow, narrow furrows, in the middle of each of which there is a raised line; the other parts of the internal surface are marked with granulations and obscure ridges.

Ventral valve nearly flat, with a backward slope in the umbonal region, and distinctly concave further forward, in the anterior central region; anterior and lateral margins abruptly curved downward, parallel to those of the other valve; beak scarcely distinct from the margin of the area, which is sublinear flat and extends the entire length of the hinge; foramen trigonal and covered by the convex pseudo-deltidium, which is sinuous on its inner edge for the reception of the cardinal process, and a kind of pseudo-deltidium of the other valve formed by the continuation of the socket plates. Interior with the anterior and lateral margins geniculated, so as to form a marginal ridge that is deeply and somewhat regularly furrowed across, while the ovarian spaces within this marginal ridge are more or less flattened and granulated; hinge teeth moderately prominent, transversely subtrigonal, and striated on their anterior and posterior faces; dental ridges extend forward and curve together, so as to form an elevated margin to the deep subcircular cavity for the reception of the muscular impressions; muscular cavity reaching near the middle of the valve, with its rim slightly notched (not emarginated) at the middle of the front; slender mesial ridge in the bottom, with narrow adductor muscular scars on each side.

Surface of both valves ornamented with fine radiating striæ that increase by intercalation, and concentric striæ which are visible only with the aid of a magnifier.

Length of a mature specimen, 0.80 inch; breadth, 0.90 inch; convexity, 0.50 inch.

Found in Warren and Clinton counties, in the upper part of the Cincinnati Group, between 500 and 700 feet above low water, at Cincinnati. Not yet known in Indiana in the same range.

For *Hemipronites elongata* (James) see vol. 1, page 240, of this Journal, July, 1874.

Hemipronites planoconvexa—(Hall, 1847).

Shell medium size, somewhat plane on one valve and convex on the other, semi-oval; hinge line usually longer than the breadth of the shell further forward; lateral extremities deflected.

Dorsal valve flat on the umbone, and evenly convex over the centra and anterior regions; beak not distinct from the edge of the sublinear area. Interior showing bifid cardinal process directed upward and outward, a little flattened on the posterior faces; sockets deep and oblique; socket ridges oblique, prominent; mesial ridge low, round, and extending to the middle of the valve while the spaces between it and the socket ridges are occupied by distinct muscular scars; whole visceral cavity irregularly, longitudinally, furrowed.

Ventral valve nearly flat, but slightly concave in the anterio-central region, and convex at the beak, which scarcely projects beyond the edge of the area; beak minutely perforated; foramen closed by a prominent, rounded pseudo-deltidium, that is transversely striated and broadly sinuous on its inner edge, for the reception of the cardinal process of the other valve; area moderately high and tapering to the lateral extremities, making it broadly triangular, flat, and sharply inclined backward. Interior showing hinge teeth well developed, sharply triangular and divergent, while from their inner bases obscure dental ridges are projected that partly encircle the usual saucer-shaped depression for the muscular scars; mesial ridge dividing the muscular cavity small, linear; cardinal margin prominent and sharp within on each side of the hinge teeth; vascular markings irregular.

Surface of both valves ornamented with moderately coarse striæ, that usually increase by bifurcation, sometimes by intercalation, which are crossed by distinct concentric lines of growth and obscure markings.

It is found at Cincinnati, about 330 feet above low water-mark, and does not seem to have a range of ten feet in thickness; whether or not it is found higher or lower elsewhere I am not informed. It is reasonably abundant where found.

For *Hemipronites*, Hallie (S. A. Miller), see vol. 1, page 148, of this Journal, April, 1874.

Hemipronites sulcata—(Vernuil, 1848.)

Shell small, more than semi-circular in outline, moderately convex, subequivalve, the dorsal valve being more convex at the middle of the front, and the ventral in the umbonal region; hinge line equaling the greatest breadth, lateral margins intersecting the hinge nearly at right angles, and rounding to the front, which is regularly rounded, or sometimes faintly sinuous in the middle.

Dorsal valve flat at the umbo and raised into a rounded, more or less prominent mesial elevation at the front; beak scarcely distinct from the cardinal margin, which has a very narrow area. Interior

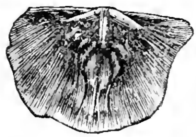


Fig. 5.—Interior of Dorsal Valve.

showing cardinal process short and deeply bifid, with very diverging socket ridges on each side, and a small mesial ridge extending forward from its base about one fourth the length of the shell; sockets for the teeth of the other valve well defined, and rather wide apart; muscular scars subquadrate and longitudinally furrowed from the socket ridges; vascular markings well defined and somewhat harp-shaped anterior to the muscular scars; punctate structure distinct.

Ventral valve a little convex at the umbo, and impressed or bent so as to form a shallow mesial sinus at the front, that rarely extends back to the middle; area well defined, rather high, flat, and a little inclined back over the hinge; foramen closed by a triangular, convex, pseudo-deltidium; beak not projecting or incurved, but inclined backward with the area and perforated by a minute circular aperture at the apex. Interior with cardinal edge sharp and distinct; hinge teeth oblique, trigonal, and prominent; dental laminæ extending forward and curving a little, but not meeting at the ends, forming a deep, somewhat half elliptical cavity, marked with an obscure, central ridge, and parallel radiating furrows.

Surface of both valves ornamented by rather fine, more or less bifurcating, radiating striæ, which are crossed by finer striæ and distinct marks of growth.

Length of a large specimen, 0.63 inch; breadth, 0.84 inch; convexity, 0.20 inch.

This form may be readily distinguished from the *H. sinuata*, by both the internal and external characters. Indeed, no two species in the genus seem to be farther apart in their internal markings.

Figure 5 is a representation of the internal part of the dorsal valve from a specimen in the collection of Mr. U. P. James.

Found in the upper part of the Cincinnati Group, at Richmond, Indiana, Freeport, Ohio, and many other localities, at an elevation of about 700 feet. It can hardly be called rare, though it is not by any means abundant.

Hemipronites sinuata—(Emmons, 1855).

Shell semi-circular, moderately convex; valves nearly equal, the dorsal most convex in the central and anterior regions and the ventral near the umbo; hinge nearly or quite equaling the greatest breadth; margins rounding regularly to the front, which forms a semi-circular curve with rarely a slight sinuosity at the middle.

Dorsal valve flat at the beak, which is not distinct from the cardinal margin, raised in the middle at the front, so as to form a low, broad, undefined mesial prominence; cardinal area narrow and inclined backward. Interior with a low, small, deeply bipartite cardinal process, from which diverge three small ridges, the two lateral of which extend obliquely outward, to form the margins of the rather well defined sockets for the reception of the teeth of the other valve, while the third ridge is central, and extends a short distance forward; muscular scars not visible.

Ventral valve moderately convex at the umbo, perforated at the beak, with a broad, shallow, undefined depression at the front; lateral regions more or less flattened; cardinal area well developed, tapering to the lateral extremities, flat, and inclined obliquely backward; foramen closed by a prominent, triangular deltidium. Interior showing a somewhat saucer-shaped cavity, formed by the low, sharp dental laminæ extending forward from the inner side of the rather well developed, oblique cardinal teeth, and curving a little toward each other, without meeting at their inner ends; muscular scars not visible.

Surface of both valves ornamented with rather coarse radiating striæ, most of which bifurcate once or oftener, while occasionally a shorter one is intercalated; crossing the whole are occasionally concentric marks of growth and finer striæ, which are visible only with the aid of a magnifier.

Length of a medium specimen, 0.65 inch; breadth, 0.88 inch; convexity, 0.20 inch.

Found about 320 feet above low water-mark, at Cincinnati, near Avondale pike, and at other places, though not common.

Prof. Meek described this species in the *Ohio Paleontology* under the name *Strophomena sinuata* (James), with a doubt as to whether or not it was identical with *Strophomena sinuata* (*Emmons*). After carefully examining the subject, I have no doubt that Dr. Emmons obtained his specimens from Cincinnati, as he says he did, and that he figured and described this species.

Genus *Strophomena*—(Rafinisque, 1827).

[*Etym.*—*Strophos*, bent; *mene*, crescent.]

Shell semi-circular, usually widest at the hinge line, concavo-convex, depressed, radiately striated; area double; ventral valve with an angular notch, progressively covered by a convex pseudo-deltidium; umbo depressed, perforated by a minute foramen; muscular depressions four, central pair narrow, formed by the adductor; external pair fan-like, left by the cardinal and pedicle muscles; dorsal valve with a bilobed cardinal process between the dental sockets and four depressions for the adductor muscle.

There are no apparent brachial processes in the dorsal valve of *Strophomena*, and it is possible that the spiral arms may have been supported at some point near the center of the shell, as in *Producta*.

Strophomena alternata—(Conrad, 1838).

Shell varying in size from three fourths of an inch in length to two inches or more, semi-oval, breadth usually greater than the length; hinge line usually longer than the breath of the valve further forward; lateral extremities usually compressed and deflected; lateral margins rounding forward to the front in a semi circular outline, or sometimes rounding in the middle, so as to present a subtrigonal outline.

Dorsal valve flattened in the umbonal and cardinal regions; more or less concave in the central and anterior portions, and more or less curved upward around the anterior and lateral margins; beak small, projecting slightly beyond the sublinear area, which is directed nearly backward. Interior with bifid, strong, cardinal process, diverging obliquely forward, flattened and longitudinally striated on the posterior faces; sockets for the reception of the teeth of the other valve well defined; socket ridges very small and uniting behind the cardinal process, to form a kind of false deltidium; muscular scars comparatively small and deeply impressed immediately in front of the cardinal process, on each side of a small, short, mesial ridge, and nearly surrounded by a low, obtuse ridge, formed by a thickening of the valve, and more or less longitudinally and irregularly furrowed; anterior and lateral margins more or less geniculated at the margin of the visceral cavity; whole surface more or less irregularly furrowed and granulated.

Ventral valve more or less convex at the umbo and over the visceral cavity; lateral and anterior margins more or less curved downward; area of moderate height, flat, and directed obliquely backward, forming with the area of the other valve an acute angle; beak very small, scarcely distinct from the margin of the area and minutely perforated; foramen broadly triangular, and arched over above by the pseudo-deltidium, which is deeply sinuous on its inner edge; the sinus being nearly or quite closed by the dental process and pseudo-deltidium of the other valve. Interior with hinge teeth moderately prominent, remote and widely divergent; dental ridges obscure, and extending obliquely outward and forward; scars of adductor muscles narrow, long, and closely approximated or almost in contact; those of cardinal muscles on each side very large, fan-shaped, but shallow, separated sometimes by a small ridge in advance of the adductor scars, and marked by radiating furrows and ridges; anterior and lateral margins usually marked by striæ and scattering granulations.

Surface of both valves ornamented by numerous radiating striæ, that increase on the ventral valve mainly by intercalation of smaller striæ, and on the dorsal valve by division, thus making the striæ more uniform in size. Subimbricating marks of growth are usually seen near the free margins of large shells and concentric striæ may be detected by the aid of a magnifier.

This species, with its varieties, has a range co-extensive with the Cincinnati Group, and is remarkably abundant. It differs so much in size and convexity, and in its proportions, that the dimensions of one shell would throw but little light upon the species. The form usually found, from low water-mark to two hundred feet above, is thin and frail, about one and a half inches, or a little more, in length and breadth, which are about equal; greatest width of the shell a little more than the length of the hinge line, and quite regularly concave on the dorsal and convex on the ventral side. The forms which come in at and about 300 feet above low water-mark, many of which continue to the Upper Silurian rocks, are quite numerous; some of them are quite flat and thin, with acute lateral extremities and no imbricating lines; others are strongly convex, thick, having many imbricating lines of growth around the margins, from the line of the visceral cavity to the edge, with lateral extremities somewhat truncated. Between these two forms there are no two shells exactly alike, and they differ in dimensions from three fifths of an inch in length to two and three fifths inches, and quite as much in width, and proportionally as much in convexity. Variety *fracta*, of Meek, I regard as a good species, and *var. nasuta* (Conrad), *var. alternistriata* (Hall), and *var. loxorhytis* (Meek), I regard as good varieties, possessing somewhat constant characters, to separate them from the type species.

Strophomena alternata var. nasuta—(Conrad, 1842).

Shell subtrigonal in outline, more deeply concave on the dorsal side, and more extremely convex on the ventral side than typical forms of *alternata;* an obtuse, undefined, mesial ridge on the ventral valve continues to the middle of the front, giving the shell its subtrigonal outline. The shell is usually thick and heavy, and strongly marked in the interior with muscular scars and furrows.

Length of an average specimen, 1.30 inches; breadth, 1.50 inches; convexity, 0.54 inch.

Its range commences about 400 feet above low water-mark, and terminates within about 200 feet, as near as I have been able to ascertain.

Strophomena alternata var. alternistriata—(Hall, 1847).

Shell semi-oval, wider than long, cardinal line extended, lighter, thinner, and less abruptly curved and thickened on the margin than the typical *alternata*; striæ more uniform in size and finer than in *alternata* proper; and the shell has a shining luster, like *L. sericea.*

Its range seems to be about as great as that of the *alternata*, and I am not sure but that the form found within 200 feet of low water-mark should rather be classed with this variety than with the typical *alternata* (though its striæ are coarse and hinge line truncated), in which latter case its range would even be the greatest, though it is much less abundant.

Strophomena alternata var. loxorhytis—(Meek, 1873).

Shell large, moderately concave on the dorsal, and convex on the ventral valve antero-centrally; hinge line extended with lateral extremities acutely angular and flattened; both valves marked near the cardinal margin, toward the lateral extremities, with six or eight distinct, more or less oblique wrinkles, similar to those on *Hemipronites subtenta.*

This form is found near the upper part of the Cincinnati Group. Its range is probably between 600 and 800 feet above low water-mark. It is not common.

Strophomena fracta—(MEEK, 1873).

Shell semi-elliptical, thin and fragile, longer than wide, hinge not extended, lateral extremities rectangular; lateral margins straight and rounding forward to the front in a semi-circular outline.

Dorsal valve flattened in the umbonal and cardinal regions, more or less concave in the central and anterior regions, and curved very moderately upward around the anterior and lateral margins; beak scarcely projecting beyond the edge of the almost linear area. Interior with flattened, bifid, cardinal process directed obliquely forward, and longitudinally striated on the posterior faces; sockets for the teeth of the other valve, and socket ridges moderately distinct; muscular scars well defined and deep, situated nearly one eighth of an inch anterior to the cardinal process, and separated by a well defined mesial ridge; muscular scars furrowed longitudinally, but the balance of the surface of the visceral region is free from lines, furrows or granulations.

Ventral valve a little convex at the umbo, compressed over the visceral region, and more or less curved downward at the anterior and lateral margins; beak scarcely distinct from the margin of the area, and minutely perforated; area flat and directed backward on a plane with the anterior margin of the shell; foramen broadly triangular and arched above by the pseudo-deltidium. Interior with hinge teeth moderately prominent, remote and widely divergent; dental ridges obscure, and extending obliquely outward and forward; mesial ridge separating an ovate visceral region, moderately distinct; visceral region marked with irregular radiating furrows and ridges; anterior and lateral margins granulated.

Surface of both valves ornamented with coarse radiating striæ, and distant imbricating laminæ of growth.

Length of a medium specimen, 1.30 inches; breadth, 1.20 inches; convexity, 0.32 inch.

Found at Cincinnati in aggregated masses, about 400 feet above low water-mark; its range seems to be confined to a few feet in thickness. While the strata at some places is literally a mass of these shells, yet, on account of their thin and frail character, it is not easy to obtain good specimens.

It is readily distinguished externally from the *S. alternata*, by its thin, fragile character, distinct imbricating lamellæ, and acute angle produced at the junction of the area of the two valves; and on the interior by the flattened, elongated cardinal process, anteriorly situated muscular scars, and smooth visceral region of the dorsal valve, and termination of the furrows and ridges in the visceral region of the ventral valve, in an oval outline, without extending into the reflected margin.

Strophomena tenuistriata—(Sowerby, 1839).

Shell semi-circular, wider than long; hinge line longer than the breadth of the valves further forward; lateral extremities acute and sometimes deflected.

Dorsal valve flat in the cardinal and central regions, and curved abruptly upward on the anterior and lateral margins; beak very small and projecting slightly beyond the edge of the area, which is sublinear and directed nearly backward. Interior with light, bifid cardinal process directed obliquely forward and flattened on the posterior faces; sockets for the reception of the dental ridges of the other valve moderately well defined; dental ridges low and gradually lost in the thickened circular elevation surrounding the muscular scars; narrow elevated mesial ridge separating the two circular muscular impressions, which are situated just forward of the cardinal process; bottom of muscular scars marked with longitudinal lines, deepest near the cardinal process; outside the subcircular elevation surrounding the muscular scars the surface is granulated and irregularly marked with more or less obscure longitudinal or oblique lines; anterior and lateral margins abruptly curved or geniculated over an elevated zone, bounding the visceral cavity, and marked with transverse obscure lines and granulations.

Ventral valve convex on the umbo and flattened over the cardinal and central regions, and curved abruptly downward on the anterior and lateral margins; beak distinct, perforated and projecting a little beyond the edge of the area; area of moderate height, gradually narrowing from the beak toward the extremities, and forming with the area of the other valve an acute angle. Interior with dental ridges divergent, and produced into a subcircular thickening of the shell or elevated ridge surrounding the muscular cavity, except at the opening on the anterior side; obscure mesial ridge separating the muscular cavity, which is longitudinally and irregularly lined; whole interior surface marked with obscure lines and granulations.

Surface of both valves ornamented with numerous round, radiating striae, that increase by intercalation and bifurcation on each valve; about six strong, concentric wrinkles over the visceral cavity mark each valve, and fine concentric striae may be seen with the aid of a magnifier.

The proportion as to length, breadth, and convexity, is not uniform by any means. Length of one specimen, 0.84 inch; width, 1.44 inches; convexity, 0.40 inch. Length of another, 0.76 inch; width, 1.20 inches; convexity, 0.40 inch. Specimens are found varying from less than one fourth the size of these to one fourth larger.

This species abounds in the upper part of the Cincinnati Group (from 500 to 800 feet above low water-mark, at Cincinnati), at almost every locality. And it also extends through the entire group, unless the form described by Mr. James as *S. gibbosa*, vol. i., p. 333, of this Journal, October, 1874, is to be regarded as a distinct species or variety. I think, however, that Mr. James' form is at least a good variety.

For *Strophomena squamula* (James), see vol. i., page 335, of this Journal, October, 1874. This form is regarded by collectors, generally, as the young of *S. alternata*, but I am inclined to think with Mr. James, that it is a distinct species.

For *Strophomena declivis* (James), see vol. i., page 240, of this Journal, July, 1874.

Genus *Leptena*—(Dalman, 1828).

Semi-circular, depressed, entering valve concave, the other evenly convex from the hinge line, which is as long as the shell is wide; cardinal area distinct, slightly rhomboidal, about equally formed of both valves; the convex or receiving valve has a triangular opening nearly filled by the projecting angle of a rhomboidal, two or four-lobed boss at the beak of the entering valve, leaving only a minute perforation, separated by a small pseudo-deltidium from the apex; punctured structure minute, often indistinct or obsolete; internal surface rough, with little points; entering valve with a small, bifid tooth at the beak, in front of which are two small diverging ridges, between which is a moderate longitudinal septum. Some species show a minute tubular foramen at the apex of the beak.

There is but one species generally recognized (*L. sericea*) in the Cincinnati Group, though Mr. James has characterized one of the forms as distinct from the others, under the name *L. aspera*, vol. i., page 151, of this Journal, April, 1874.

Leptena sericea—(SOWERBY, 1839).

Transversely oblong, substance of the shell thick, very coarsely fibrous; hinge line slightly exceeding the width of the shell; cardinal angles acute, sides gently convex, slightly converging; front nearly straight, wide; receiving valve much and regularly arched to the deflected margins; greatest depth at one third from the beak; entering valve slightly flattened in the rostral portion, rather abruptly arched to the margin; greatest depth at two thirds from the beak; often a few small, converging wrinkles on each ear; both valves radiated with extremely fine, hair-like striæ, separated by sulci equaling them in size, containing close rows of very minute punctures; at intervals of from one half to one fourth (near the margin) of a line apart certain of the striæ become about twice the size of the others, including between each pair from five to ten smaller; about thirteen to sixteen striæ in the space of one line, in the middle of front margin, at three lines from the beak; cardinal area in each valve low, triangular; that of the receiving valve about a third larger than that of the entering valve; rostral tooth very large, five-lobed, nearly filling the triangular foramen of the receiving valve, which is as wide as high, and the apex of which is closed by a small deltidium; internal cast of receiving valve showing two very short cardinal teeth bordering the triangular boss of the foramen, diverging at about 135°, from the ends of which proceed two longitudinal, slightly incurved, slightly diverging ridges (forming slight furrows on cast), forming the outer boundaries of two long, prominent, obtusely ovate muscular impressions, wide, and only separated near the beak by a very slender sulcus of a mesial septum, scarcely one third the length of the shell; anterior boundaries sharp, diverging at about 70°, inclosing between them a prominent semi-elliptical mesial space, and narrowing the anterior ends of the muscular impressions, from each of which extend four or five thick diverging and dichotomising impressions of the pallial and ovarian vessels, a couple of similar dichotomising impressions on each side of the mesial space, and three or four very short ones on each lateral margin; the rest of the surface marked with obscure traces of the external striæ, punctured in lines, the punctures becoming much larger at the margin, between the branches of the pallial vessels; interior of entering valve concave for two thirds the length from the beak, the margin abruptly arched over, very closely punctured (not in rows), and marked at the edge with numerous, short, simple ridges; two very short cardinal teeth diverge from the rostral tooth; muscular impressions with very prominent boundaries all round, each one oblong, depressed, and nearly smooth in the middle, or subquadrate, slightly longer than wide; the two together transversely oblong, one third wider than long, the width equaling the length of the valve; the two prominent inner boundaries leave a deep sulcus between them, at the anterior end of which only a very short mesial septum is developed, not reaching nearly to the beak; interior of the muscular impression nearly smooth, each divided by a faint diagonal ridge; the space immediately in front of the impressions coarsely pitted and marked with a few obscure, branching impressions of pallial vessels, none of which are visible on the deflected front; cardinal angles irregularly punctured, and with minute wrinkles. Width, eight lines; proportional length of receiving valve, $\frac{55}{100}$ths inch; of entering valve, $\frac{50}{100}$ths inch; depth of entering valve, $\frac{15}{100}$ths inch; depth of receiving valve, $\frac{30}{100}$ths inch.

Its range is co-extensive with the Cincinnati Group.

Family *Spiriferidæ*.

Shell free, inequivalve, varying greatly in form and ornamentation, according to the genera and species; with or without a cardinal area; oval appendages large, provided with calcified, ribbon-shaped supports, which are spirally coiled, so as to form two cones, the apices of which are directed outward toward the lateral margins of the valves; shell structure fibrous or fibro-punctate.

Animal unknown; apparently sometimes attached by a muscular peduncle.

This family includes *Zygospira* and *Trematospira*, with other genera.

Genus *Zygospira*—(Hall).

Shells bivalve, equilateral, inequivalve; surfaces plicate in the typical species; a sinus on the dorsal valve. Internal spires arranged somewhat as in *Atrypa*, with a broad loop passing from the outer limbs of the spiral band entirely across, from side to side, near to or above the center, and close to the inner side of the dorsal valve.

(*Z. modesta*, typical sp.)

Zygospira modesta—(Say).

Shell small, suborbicular or plano-convex, sometimes a little wider than long; posterior lateral margins converging to the beaks at an obtuse angle; lateral margins rounded to the front, which is sometimes straight or slightly sinuous.

Dorsal valve with a shallow, undefined mesial sinus of moderate breadth at the front, but narrowing posteriorly and usually fading out before reaching the umbo; surface on each side of the sinus gently convex centrally, and sloping gradually to the lateral margins; beak but slightly prominent and incurved.

Ventral valve with a more or less elevated mesial ridge, generally most prominent near the middle, and somewhat depressed anteriorly, while the slopes on each side are distinctly compressed; beak small, abruptly pointed, perforated, projecting beyond that of the other valve, and rather distinctly arched; margin on each side of beak carinated, so as to give the appearance of a kind of false cardinal area.

Surface of each valve ornamented by about eighteen simple, rounded plications, of which one at the umbo and five at the front of the dorsal valve occupy the mesial sinus; the one extending from the umbo (or central plication) is the largest, and corresponds with a deep furrow in the middle of the mesial ridge of the ventral valve; about four plications occupy the mesial elevation of the ventral valve, two on each side of the deep central furrow; marks of growth obscure and surface obscurely punctate.

Found throughout the Cincinnati Group, at all elevations, in great abundance, and in a good state of preservation.

Zygospira Cincinnatiensis—(James).

This variety or species differs from the last in its larger size, greater proportional breadth, more prominent mesial elevation, deeper furrow in the middle, deeper mesial sinus, and more spreading and coarser lateral plications. Its lateral margins are generally much compressed.

Prof. Meek thinks it may be only a robust variety of *Z. modesta.*

Found on the hills back of Cincinnati, associated with the *modesta*, at elevations from 250 to 400 feet above low water-mark.

Zygospira headi—(Billings, 1862).

Shell attaining a medium or rather large size, longitudinally oval, the front being regularly rounded, and the lateral margins more broadly rounded, or sometimes slightly straightened along the middle; valves both rather evenly convex. Dorsal valve a little less convex than the other, its greatest prominence being near the middle, but without any traces of a mesial ridge; beak very short and incurved.

Ventral valve with its greatest convexity behind the middle; mesial sinus almost obsolete, or only consisting of a slight flattening along the middle of the anterior slope, on each side of which the lateral slopes are sometimes very slightly compressed; beak only moderately prominent, obtusely pointed, and strongly incurved upon that of the other valve, while on each side of it a slight carination extends laterally, so as to give somewhat the appearance of a false area. Surface ornamented by fine, even, simple, radiating striæ. Interior unknown.

Length of medium sized specimen, 0.61 inch; breadth, 0.52 inch; convexity, 0.34 inch.

Found in the upper part of the Cincinnati Group, at an elevation of about 600 feet above low water-mark, near Clarksville, in Clinton county, Ohio, and about ten miles south of Maysville, Kentucky. It is regarded as a rare fossil.

Genus *Trematospira*—(Hall, 1859).

[*Etym.—trema*, foramen; *speira*, spire.]

Shell transverse, elliptical or subrhomboidal, inequivalve, furnished with internal spires (arranged as in *spirifer*). Hinge line shorter than the width of the shell; cardinal angles rounded. Valves articulated by teeth and sockets; beak of ventral valve produced or incurved, and truncated by a small, round perforation, separated from the hinge line by a deltidium. A deep, triangular pit, or foramen, beneath the beak of the ventral valve, which is filled by the closely incurved beak of the dorsal valve. False area sometimes defined.

Surface marked either with strong, simple plications, or finer fasciculate or bifurcating striæ, which cover also the mesial elevation and depression. Shell structure punctate.

This genus is regarded by some authors as a synonym for *Retzia*. (King, 1850).

Trematospira (?) quadriplicata—(S. A. Miller).

[*Etym.—Quadriplicata*, in allusion to the four costæ on the mesial elevation of the dorsal valve.]

Shell transversely suboval, subglobose; dorsal valve most convex; posterior lateral margins somewhat straightened and converging to the beak; lateral margins rounded to the front, which is nearly straight in the middle; area none.

Dorsal valve strongly convex, most prominent in the middle or a little anterior; mesial ridge prominent as it approaches the middle and anterior parts, and consisting of four simple, angular, radiating costæ; lateral slopes each occupied by six similar costæ, regularly sloping to the margins; beak closely incurved beneath the beak of the ventral valve.

Ventral valve moderately convex; mesial sinus not quite reaching the beak, but deep and well defined in the middle and anterior regions, and containing three simple, angular, radiating costæ; lateral slopes each occupied by six similar costæ gradually curving to the margins; beak prominent, perforated (?) and slightly incurved upon that of the dorsal valve.

Fig. 6.—Front view.

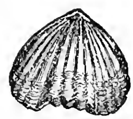


Fig. 7.—Dorsal view.

Surface of both valves marked by distinct lines of growth crossing the plications. Sometimes the mesial ridge of the dorsal valve in old specimens becomes so prominent as to be humped anteriorly. Interior unknown.

Length of specimens collected varying, from 0.34 to 0.66 inch; breadth, from 0.32 to 0.74 inch; convexity, from 0.18 to 0.48 inch.

I collected this species in the railroad cut at Paris, Kentucky, but do not know the exact position of the rocks in the Cincinnati Group. I suppose them to be somewhere in the upper part. It may be that this species should be classed in the genus *Rhynchonella.*

Trematospira (?) granulifera—(Meek, 1872).

Shell transversely oval, length about four fifths the breadth, moderately convex, convexity of the two valves being nearly equal; lateral margins rather narrowly rounded in outline; front and anterior lateral margins broadly rounded, or perhaps the former sometimes straight or slightly sinuous in outline in the middle; cardinal margin nearly straight on each side, and sloping at an angle of about 140° from the beaks toward the lateral extremities.

Dorsal valve nearly evenly convex, its greatest prominence being slightly behind the middle, provided with about thirteen simple, angular, radiating plications, five of which on the middle are smaller than the others (the middle one being smallest and not continued to the beak) and forming together a very low, flattened mesial elevation, scarcely rising above the general convexity; beak rather strongly incurved.

Ventral valve of much the same form as the other, excepting that its beak is somewhat more prominent, perforated (?) and incurved upon that of the other valve; while two of its middle costæ are much smaller than the others, and the first one on each side of these is intermediate in size between the smallest central ones and the largest on the lateral slopes; these four smaller ones being a little depressed, so as to form a shallow mesial sinus that is not continued to the beak. Crossing all of these plications of both valves are numerous fine lines of growth; while the entire surface, as seen under a magnifier, is occupied by minute projecting points, like grains of sand, and between these, a higher magnifying power shows the whole surface to be very minutely and regularly punctate. Interior unknown.

Length, 0.37 inch; breadth, 0.50 inch; convexity, 0.27 inch.

Found at Cincinnati, but exact elevation unknown.

Prof. Meek suggests that this species may be identical with *Retzia Salteri*, of Davidson.

A Brief Chapter on Sacrificial Mounds. (By L. M. Hosea.)

Not far from Springfield, Missouri, stands an imposing mound, erected by races who dwelt ages ago in that locality, exhibiting, in a marked degree, those characteristics which seem to identify the Mound-Builders of the Mississippi valley with the extinct peoples of tropical America. Until recently, no examination other than of the surface had been made of this interesting monument, which is now shown to possess features of great interest bearing upon the inquiry as to the religious customs of the pre-historic races of the United States.

The mound in question, as we gather from the accounts of newspaper correspondents, is situated twelve miles north of Springfield, in Green county, two miles east of the Bolivar road, and crowns the summit of a hill, which gradually rises to an elevation of three hundred feet above the surrounding country.

It is of earth, interspersed with large, limestone bowlders, some of which, exposed upon the sides and summit of the mound to the action of the elements, present an appearance described as resembling worm-eaten hickory or ash, but more deeply corrugated. The general form of the mound is a truncated cone, whose base diameter is five hundred feet; summit diameter, one hundred and thirty feet; and perpendicular altitude, sixty-two feet.

A correspondent of the *St. Louis Times* thus describes its salient features:

"Encompassing the mound on all sides—save a causeway on the north—is a trench, about two hundred feet wide, and now about five feet deep, though it has apparently filled several feet in the ages that have elapsed since its excavation. From this moat was doubtless taken the earth used in rearing the mound. The approach or causeway which leads across the trench from the north is ten feet in width. Ascending from this causeway to the summit of the mound are the remains of a rude flight of stairs, constructed originally of roughly hewn stones. Most of these steps are now displaced, and quite a number have rolled down into the trench below, but there is unmistakable evidence that they were at one time arranged in regular order of ascent, and could doubtless be again replaced in position by an intelligent architect.

"By a series of investigations, I found that about a foot beneath the surface there was a regular and solid platform of stone covering the entire top of the mound. This platform, though constructed by rude and unmechanical hands, is placed in position with a precision and firmness that might well defy the ravages of the elements in all coming ages.

"About twelve feet from the northern edge of the mound, and directly on a line with the approach and stairway, I noticed a very perceptible elevation of the earth, covering an area of about twenty by fifteen feet, and driving a pick into the elevated ground, the point struck upon solid rock a few inches below the surface. Knowing the rock struck was considerably more elevated than the general level of the layer of stone, I drove my pick into the elevation in several other places, always finding solid rock near the surface.

"Determined to investigate further, I called my assistants to my aid, and soon a considerable portion of a large flat rock was laid bare. Pushing our work, we soon unearthed a piece of workmanship that an antiquarian would have worked a week to bring to light. The newly discovered curiosity consisted of a flat rock, twelve feet long, ten feet wide, and eleven inches thick. The center of the stone was hollowed to a depth of six inches, with a margin of about one foot around the edge.

"At the south end of the stone, a round hole, five inches deep and four in diameter, was drilled. Among the dirt taken out of this basin hewn in the stone, was a large, fossil tooth, and a piece of a small, broken, stone column, and several bits of pottery ware."

Brief and unsatisfactory as it is, the student of American archæology will not fail to recognize in this description a type of the Teocalli, whose bloody rites filled the conquerors of Mexico with horror and amazement.

The conventional form of the Aztec Teocalli was a four-sided-truncated pyramid of several stages, on whose summit were the sacrificial altars whereon victims were immolated, and temples containing the shrines and images of the gods. The Aztecs took as their model for these structures, the great pyramid of Cholula, reared by the Toltecs at a much earlier period, in imitation of the elevated pyramids of Teotihuacan, which are said to be the most ancient of all, and are ascribed by dim tradition to an extremely ancient race, called Olmecs. In the venerable monuments last mentioned we have the oldest known type of pyramidal structures on the North American continent. The two largest were four-sided, and faced the quarters of the heavens. Three stages of each are yet visible. Flights of steps, constructed of hewn stones, led up to flat summits, upon which were discovered fragments of altars. The larger structure, or "House of the Sun," as called in the language of the Aztecs, was six hundred and eighty-two feet square at the base, and two hundred and twenty-two feet in height. The smaller, or "House of the Moon," was of about half these dimensions. Surrounding them, covering a vast plain, were other tumuli of earth and stones, disposed with regularity in groups, forming straight lines or squares with avenues between. Ancient as are these hoary monuments, their existence reaching back into a period of which history affords no account, and even tradition is well nigh silent, they nevertheless mark an advanced period of art, preceded—as Bayard Taylor says of the earliest Egyptian antiquities—by a long stage of unrecorded development.

The pyramid, regarded as a highly developed type of the simple tumulus, affords, by its peculiarities of structure, and use a legitimate means of tracing the ethnic relations of the builders. Hardly a variation from the common form of the Teocalli of tropical America, is unrepresented in the earth mounds of the United States. The Missouri 'mound under examination, corresponds in the feature of a stairway leading directly to the summit, with the pyramids of Teotihuacan—the earliest type of which we have any account; while the flat summit and altar indicate an identity of use. Structures built upon this plan are not uncommon throughout Central America and

Mexico, and are generally admitted to belong to an earlier period than the Aztec domination. Papantla, Tusapan, and Misantla, in Mexico, and Uxmal, Palenque, Chi-Chen, and other localities in Central America, exhibit fine illustrations of this peculiar type, all of which were erected as substructures for temples of worship, or as elevated platforms for sacrifices. In the United States the representatives of this class of pyramidal structures consist of mounds, in the form of truncated cones or pyramids, whose summits are reached by graded ways, affording an easy mode of ascent. Elevations of this class are more common in the southwest than elsewhere, but may, nevertheless, be observed in many of the Ohio earthworks. Illustrations occur at the Cedar Bank works, in Ross county, as also in the Portsmouth, Newark, and Marietta groups, in isolated structures of this description, which, as we progress southward into Alabama, Mississippi and Louisiana, become more numerous, massive in character, and elaborate in detail, until they reach their greatest development in the highly ornamented stone pyramids of Mexico. The great mound at Cahokia, Illinois, may be mentioned as a magnificent example of this class.

The imposing pyramid of Cholula, which served the Aztecs as a model for their Teocallis, marks a departure from the foregoing type. Its construction, according to the researches of Humboldt, is to be ascribed to the Toltecs, who invaded the vale of Anahuac, by the traditional accounts of the Aztecs, at a period corresponding with the sixth or seventh century of our era. In form, it may be described as a succession of truncated pyramids, one above another, forming, at each stage, terraces, connected by stairways. Of these stories, four remain, constructed chiefly of sun-dried bricks and layers of stone, now so resolved by the elements, and overgrown with vegetation, as to be almost undistinguishable from a natural elevation. Upon close examination, however, the regular courses of brick used in its construction, and portions of the stucco which once encased its exterior, may still be discerned.

The great Teocalli, in the city of Mexico or Tenochitlan, which had been completed by the Aztecs shortly before the conquest, and may be regarded as the type or representative of most of their later structures of that class, consisted of a series of half cubes or truncated pyramids, diminishing in size as they rose one above another, with connecting stairways so placed as to compel an entire circuit of the terraces, by the train of priests and worshipers, at each stage of the ascent to its summit. The only noticeable difference in these two types, is in the manner of reaching the summit — in the first, by a direct stairway or graded ascent, and in the second, by a mode compelling a circuit of the entire structure.

Representatives of the second class are equally common among the mounds of the United States. A similar modification of the means used, however, in accomplishing the ascent, is to be observed in the spiral pathway leading to a truncated summit. An illustration of this is observable in the Portsmouth group of works, in a mound of this description, surrounded by numerous parallel walls or embankments. Examples also occur in Kentucky, Tennessee, and other Southern States. A group described by Bartram, deserves especial note in this connection, situated on the Savannah river, about five miles above Fort James (Dartmouth), and consisting of "conical mounts of earth and four square terraces." Of the principal mound, he says:

"The great mound is in the form of a cone, about forty or fifty feet high, and the circumference of its base 200 or 300 yards, entirely composed of the rich, loamy earth of the low grounds. The top or apex is flat; a spiral path leading from the ground up to the top is still visible, where now grows a beautiful, spreading, red cedar; there appear four niches excavated out of the sides of this hill, at different heights from the base, fronting the four cardinal points; these niches or sentry boxes are entered into from the winding path, and seem to have been meant for resting places or lookouts."

Similar niches were observed in some of the Teocallis of Mexico.

The uses to which these mounds were put were undoubtedly identical, both in the United States and Mexico, and indicate a similarity in modes of worship and customs pertaining to the religious ceremonial, which leaves little doubt as to the substantial identity of the two races, at a period far anterior to the Aztec supremacy. In the vague and often incomplete accounts of works of this kind in the United States, we are uninformed whether there existed, at the time of their discovery, any traces of the altars which in Mexico were found upon the level summits of the Teocallis, and upon which the barbarous Aztec priest was wont to stretch the quivering form of his victim, in the bloody and revolting sacrifices of his worship. It would seem that, in some cases at least, temples crowned their summits, of which no remains have survived the ravages of time. In a forest-bearing country like the fertile valleys of the Mississippi, it is altogether probable that the abundance of wood led to its almost exclusive use as a material for the erection of such structures upon the mounds, which in a few years decayed and left no trace; and we are therefore left to infer their former existence solely from the design apparent in the erection of elevated foundations, and from the more enduring evidences remaining on similar elevations in tropical America. What remains of these monuments, taken as a whole, corresponds exactly with the imperishable structures of Mexico, modified only by the different conditions which our own country presented—one class being of earth, the other of stone or brick. To the same modifying influences may be attributed the erection of wooden temples, that in the course of ages have decayed and became resolved again to earth; while in a rocky and at best sparsely wooded country, doubtless soon denuded of timber by a teeming population, nature compelled resort to a material, which, by indelibly preserving the results of art, reacted upon art itself, and thus produced magnificent pyramids and temples which compare with the finest efforts of ancient oriental nations.

In the Missouri mound, however, we have more substantial proof in the stone altar, that in form also marks a period antedating the Aztec. The Aztec altar or stone of sacrifice was usually a single rectangular block, with a convex top, over which the body of the victim was bent in such a way as to facilitate the tearing out of the palpitating heart from the upturned breast; but among the antiquities of a more ancient date, discovered in Mexico and Central America, are altars with the upper surface hollowed into a basin-shaped cavity, with a groove or channel leading from it, similar to the one in question. Such altars were not unknown to other ancient nations who practiced similar rites. Tacitus, speaking of the ancient forests of Anglesea, the stronghold of Druidical worship in England, describes such altars of stone upon which the blood of slaughtered victims was evaporated. The numerous remains of altars and dolmens, discovered there in recent times, comprise many corresponding precisely, in the feature in question, with the altar-stone of the Missouri mound. Such a depression is the universal characteristic of the altars covered by the so-called "altar-mounds" of Ohio, though none of these, so far as known, consist of a single stone. They are generally composed of burned clay or stones, heaped with care into symmetrical forms, and rest upon the original surface of the ground. The depressions, in most instances, are found to contain calcined human bones and fragments of utensils or ornaments, deposited with the dead in whose honor the mounds appear to have been raised; and from the uniformity of this circumstance, in mounds of this description, their construction is inferred to have been solely for sepulchral purposes, or at least in connection with sacrifices performed for the dead. It is probable that the so-called "signal mounds," and high hills, upon whose summits the evidences of long continued fires are apparent, served the purpose of the Teocallis among the ancient Mound-Builders, as places of general sacrifice and also signal stations, as was the case among the Aztecs. The debris of burned stones and clay always present upon these elevations, are probably the remains of altars similar to those discovered in the altar-mounds; and we do no violence to probability in further attributing the construction of a more elaborate and enduring altar of a single stone to the same development in arts which the mounds themselves exhibit, in their general features, as we proceed southward.

It is said that the custom of the Chinese, 2,300 years before our era, was to offer sacrifices to the supreme being, Chanty, on four great mountains, called the four Yo. The sovereigns, finding it inconvenient to go thither in person, caused eminences, representing these mountains, to be erected near their habitations. Heaven was thus worshiped upon a mound round and high, to represent the sky; and Earth, upon a tumulus square and low, to represent the earth. However satisfactory may be the clue thus afforded to the origin or meaning of these forms, the frequent reduplication of the square and circle in the mounds, and also in the earthen inclosures of the Mound-Builders, is a circumstance worthy of careful examination. The Creeks, who may have remotely derived the elements of their semi-civilization from the mysterious race of the mounds, displayed the same attachment to these forms in their public structures. They too, in common with other southern tribes who may be supposed to have felt, more or less directly, the influence of the civilization of the extinct races whom they or their predecessors supplanted, were sun-worshipers, and maintained a continual fire, as we are told by Bartram and other early witnesses, within a circular edifice, called the "Rotunda," which, from its form, was held to be a symbol of the sun.

From the considerations thus briefly adduced, we can not doubt the prevalence, among the Mound-Builders, of religious customs in the main similar to those prevailing among the Mexican races before the conquest; and the substantial identity, in type as well as in details of construction, of the elevations upon which religious rites were celebrated, leads to an inference of a similar identity of the races who constructed them in both sections of the continent.

Though ignorant of the minor features of their sacrificial worship, excepting so far as adopted by the Aztec races, there is no reason for supposing the cannibalism prevalent among the Aztecs as part of their ritual, was practiced by the Mound-Builders. On the contrary, this barbarous custom of the Aztecs originated, according to their own testimony, among themselves; and was a feature entirely inconsistent with the more humane and elevated system which they appropriated from the Toltecs and other races who preceded them. The Missouri mound, as has been shown—as indeed do all the structures of that class in the United States—more nearly resembles the earlier Toltec structures which served the Aztecs as models for their own; and hence our inferences as to the religious system of the Mound-Builders, point to the same elevated source—a system which, according to the traditions of the Aztecs, embraced a policy in some respects as rational as any of modern times.

It is evident, that whatever may have been the religious belief and practice of these ancient people, it was the prominent and pervading feature of their civilization. Religious works and tombs alone remain to attest their devotion, while private dwellings and other structures have long since crumbled into dust. Noble obelisks, porticos, pyramids erected as pedestals for temples, and massive structures of stone, accurately fitted and covered with intricate and elaborate carving, lie buried and forgotten in the gloomy recesses of Central American forests, or nestle among the picturesque heights of Mexico, all bearing the stamp of the religious zeal and veneration of the builders. The more unpretending works of the United States bear equally unmistakable evidence of their sacred character.

The peaceful and elevated character of the Toltec system, upon which the Aztecs engrafted their barbarous customs, was one of its distinguishing features. Their supreme deity was a benevolent being, whom they held in such reverence as to deter any attempt at embodiment in material forms. His chief representative, among the inferior deities, was the god Quetzalcohuatl, whom they venerated with almost equal fervor. To this beneficent being, they ascribed their knowledge of the arts of civilization and government; in which respect Osiris of the Egyptians presents a striking analogy, strengthened by the fact, that, according to the respective traditionary mythologies, after teaching these arts, both departed to other nations to impart the same knowledge.

The advancement made by the ancient Mexicans in astronomy, is also important to be considered in connection with the uses made of the elevated Teocallis. As the rise of astronomical knowledge among the Egyptians is attributed to the pastoral custom of tending flocks by night, under cloudless skies, so it may be referred among the American races to the custom of observing the firmament, during the long watches of the night, from the elevated platforms of the Teocallis. "That they should be capable," says Prescott, concerning the ancient Mexicans, "of accurately adjusting their festivals by the movements of the heavenly bodies, and should fix the true length of the tropical year with a precision unknown to the great philosophers of antiquity, could be the result only of a long series of nice and patient observations, evincing no slight progress in civilization."

The location of the temple or sacrificial mounds of the United States, bears, in every instance, an obvious reference to an unobstructed view of the firmament, and especially of the sun in his rising and setting. Structures of this character are most frequently placed upon east and west lines. Judge Yaple, of Cincinnati, who has been familiar from boyhood with the mounds of the Scioto and adjacent valleys, gives this as their most prominent characteristic; and other investigators concur in a similar observation respecting such works elsewhere. These peculiar features bear direct reference to the same intimate connection between the religious ceremonial and observations of the heavenly bodies which distinguished the Aztec system.

The generally received opinion as to the astronomical use of the "telescopic tubes" of the Mound-Builders, founded upon observations of a similar instrument represented in sculpture in South America, Central America, and Mexico, may be referred to in this connection. Several of these tubes were discovered in the Grave Creek mound—an elevation of the class described—and in many other mounds in various localities. President John A. Williams, of Daughters' College, Harrodsburg, Kentucky, possesses a tube of this kind, found in a cave in Tennessee, so peculiarly and exquisitely wrought as to leave little doubt upon this subject, notwithstanding Mr. Jones, in his "Antiquities of the Southern Indians," assigns an entirely different use to these implements.

What has been said of the pyramidal elevations of North America, applies with almost equal pertinency to those of the southern part of the continent, especially that lying westward of the Andes. Peru is especially rich in the remains of an ancient civilization, existing before the time of the Incas. The region about Lake Titicaca, Old Huanuco, and Tiahuanaco, is covered with the wrecks of a civilization more advanced in the arts of masonry, architecture and sculpture, than any pertaining to the Inca dynasty. Although these remains display certain characteristics which distinguish them in detail from the structures of the north, yet the objects of their construction were evidently similar; and, so far as they relate to the religious ideas of the builders, indicate a sentiment common to all the early American races, which finds no counterpart among the nations of the Old World. Pyramidal elevations, ascended by graded ways and terraced structures, are still visible, and by their frequency suggest the same general customs which distinguish the ancient people of Mexico and Central America, notwithstanding the minor differences which belong to a separate development in arts springing from a common source.

In conclusion, we may say, that while the problem of ancient American civilization is yet without solution, there is reason to hope that the growing interest in the subject may develop results commensurate with its importance. The question: Who were the Mound-Builders? is yet unanswered. There is abundant internal evidence in their remains that they were closely identified with races inhabiting the tropical regions of America, and, perhaps, for considering their settlements in the great basins of the Mississippi and Ohio as colonies emanating from Mexico at a very ancient period. But whether the ancient Mexicans and kindred nations are to be regarded in the light of indigenous races, or as immigrants from Asiatic countries, is a question difficult of solution. While Baron Humboldt, whose researches entitle his conclusions to great weight, regards the Toltecs, and the other more ancient tribes whose names are preserved in Central American tradition, as northern invaders of the vale of Anahuac, Mr. Squier, whose opportunities were perhaps equally good, believes they emanated from regions still further south. Both may be right; and if we conceive of a race and civilization existing at a more remote period than Humboldt takes into account, extending their settlements through Texas and up the Mississippi and its tributaries, and afterward dispossessed and driven out by a great wave of invasion from the north, of which the Toltecs, Olmecs, and other tribes, led the van, many of the difficulties attending the inquiry are removed. We are then remanded to Mexico and Central America, whose monuments and inscriptions have thus far baffled interpretation, as the fountain-head of the Mound-Builders civilization. Although the unsettled political condition of those countries has for years rendered investigations of their ruins precarious and unsatisfactory, we may at least hope that this condition of things will cease, and permit a more thorough and extended examination, in methods developed by the experience of recent years in other countries.

When the impression, so prevalent among European scholars—that the pre-historic races of America were rude savages, destitute of culture, and without remains worthy of study—shall be removed, and the magnificent ruins of Central America, with their sculptured inscriptions subjected to the critical examination of men "learned in the learning of the Egyptians," it is highly probable that these interesting problems will receive solution, and the Mound-Builders assigned at least a relative position in history.

Review of the Present State of the Controversy Regarding the Motion of the Glacier. By PROF. E. W. CLAYPOLE, B. A., B. Sc. (Lond.), Antioch College, Yellow Springs, Ohio.

The motion of the Swiss glaciers down their rocky channels had attracted the attention of those who lived in the neighborhood long before it became an subject of study to men of science.Their alternate advance and recession had rendered them, for ages, dangerous enemies to the farmer of the upland valleys of Switzerland.

Sometimes for years they shrunk back into their mountain glens, tempting the villager to undertake the task of removing the huge mounds of snow, and of reclaiming the masses of sterile clay they had left behind them. And again, perhaps in his own life-time, or in that of his son, or grandson, they advanced, and almost before the husbandman could reap the profits of his labor, ruthlessly plowed up and swept down before them, crop, and sod, and soil, with the hut of the proprietor, and sometimes the whole village to which he belonged.

When at length awakening science began to ask the cause of this mysterious movement, an easy and obvious answer was found in the natural properties of ice. The glacier slid down the valley. This explanation of the phenomenon, which is associated with the name of the Swiss naturalist, De Saussure, has maintained its ground for many years, under the name of "the sliding theory of glacial motion," in spite of the manifest difficulty of conceiving how even so slippery a substance as ice could slide down an almost level valley, with a rough or rocky bottom, to which, during some part of the year, at least, it was more or less frozen. In De Saussure's own words—"These frozen masses, carried along by the slope of the bed on which they rest, disengaged by the water (arising from their fusion, owing to the natural heat of the earth) from the adhesion which they might otherwise contract to the bottom, sometimes were elevated by the water, must gradually slide and descend along the declivity of the valleys or mountain slopes (croupes) which they cover. It is this slow, but continued sliding of the icy masses (glaces), on their inclined bases, which carries them down into the lower valleys, and which replenished continually the stock of ice in valleys warm enough to produce large trees and rich harvests."*

But it can be proven by the principles of mechanics, that a sliding glacier must slide with increasing velocity until it becomes an avalanche, and this objection alone may be considered fatal to De Saus-

* Voyages dans les Alpes, p. 535.

sure's theory. In addition, however, to this, it fails to account for more than a small part of the phenomena brought to light by recent and accurate observation in the Alps, and, in consequence, has long been altogether abandoned.

Another theory was put forth by De Charpentier, which was free from the difficulties besetting that of De Saussure, inasmuch as it supplied another motive force than the apparently insufficient one of gravitation. He took advantage of the expansion of water in freezing, and suggested that the water from the surface of the glacier, produced by the heat of the sun, flowed into the crevices in its interior, and there was again frozen, and by its expansion forced the glacier to move in the line of least resistance, that is, downward. This has received the name of the "dilatation theory" of glacier motion, and though, no doubt, sometimes a real, is, like De Saussure's, an altogether insufficient cause; not being capable, on the most liberal construction, of accounting for more than a very small fraction of the movement observed. Like its predecessor, it is now, consequently, quite abandoned.*

The experiments of Agassiz and J. D. Forbes, in 1841 and 1842. upon the glacier of the Unteraar and the Mer de Glace, formed an epoch in the study of the subject. Correct data were then for the first time given to the world, by which to test the adequacy of any theory to account for glacier motion. Tried by this test, the two above mentioned signally failed. It has been asserted that the movement was made by fits and starts, but these experiments proved that it was, on the contrary, slow and continuous. It had also been assumed that the ice moved as a single mass; whereas, it was now shown that the motion is differential, inasmuch as the middle moved faster than the sides, and the surface faster than the part below. The movement also, it was now found, had been very much under-estimated by early writers, and instead of amounting to only 15 or 20 feet in the year,† the Mer de Glace actually moved, as the villagers had always maintained, at the rate of about a yard a day.

The unhappy controversy which ensued between these two colaborers in regard to priority of claim, and which has been revived since their death, is well known and need not be noticed here. It will be sufficient to observe, that the result of these experiments suggested to the mind of J. D. Forbes a theory of glacier motion, which had also occurred some years earlier to M. Rendu, bishop of Annicy, an earnest student of the subject, and which he has left on record. This theory is strik-

* See Charpentier Essai sur les Glacier, 1841, and Agassiz Etudes sur les Glaciers, 1840.

† Ebel "Swiss Guide Book."

ing, and at first appears in the highest degree improbable, yet, when its one great postulate has been granted, it explains many of the phenomena more satisfactorily than any previously promulgated.

Ice, on this, which is called the viscous theory, is assumed to be a body possessing the same property of plasticity as pitch or treacle, and capable, like them, of flowing in a channel and of spreading itself out over a flat surface. The glacier, in this view, resembles a river, and flows according to the same laws and in the same manner, subject only to differences which result from the lowness of the degree of viscosity assigned to ice even by the strongest advocates of the theory in question.

Possibly it was the absence of any plausible competitor, as much as its own logical claims, which enabled this theory to command so large a measure of acceptance during so many years. It was ably expounded by its originator, and as ably defended by others equally or more eminent in physical science in its original form.*

But it can scarcely be said to exist in its original form at the present day. It has fallen; and the blow beneath which it fell, came from a mathematician. In assuming that ice flows as water flows in essence, and that the flow of the two differ only in degree, Forbes had made an assumption that could be proved or disproved. Liquidity is a consequence of want of cohesion between the molecules of a substance, or else of the subjection of their mutual cohesion to the influence of heat. In any case, a certain force is needed to make the most mobile liquid flow, and this force increases with the cohesion, until the substance ceases to be liquid or even viscous. The amount of force required to make molecule slide over molecule, as occurs in the flow of liquid and semi-liquid bodies, is called the *shearing force*, and must be determined by experiment in every case. In the solid bodies this shearing force is very high, amounting in wrought iron to 50,000 lbs. per square inch, and great pressure is needed to make their particles slide one over the other. The solidity of ice rendered it doubtful, how far the motion of a glacier could be attributed to the yielding of this substance under the mere force of gravitation, and the late Henry Moseley, Canon of Bristol, England, investigated the subject, and published his researches in a paper printed in the *Proceedings of the Royal Society of London*, for March, 1869; in two papers, contributed to the *London, Edinburgh and Dublin Philosophical Magazine* for May and August of the same year; and in a paper read before the British Naturalists' Society, and published in their proceedings, for December, 1869. He determined the shearing force

*We say, "in its original form," because the question at issue is not, "Does ice behave like a viscous body?" which is not doubted, but, "Is ice viscous?"

of ice by a series of experiments, and applying his results to the Mer de Glace, concluded that in the conditions under which the ice in that glacier moved, the unit of shear could not be less than 75 lbs. per square inch, whereas, gravitation could only produce the observed movement of the glacier, on the supposition that the unit of shear did not exceed 1.3489 lbs. per square inch. So vast a difference between the two—the required force being between fifty and sixty times as great as that which could be allowed to gravity—led Mr. Moseley to sum up his results by saying, that "the Mer de Glace would only descend by its weight, if the ice were of the same degree of hardness as soft putty, and of the same specific gravity." "The unit of shear," he says, "in soft putty, is from 1½ to 3 lbs. per square inch." The mechanical objection has never been refuted, and at the present day the theory that ascribes viscosity to glacier ice can only be said to exist on account of the lack of any other to take its place.

Canon Moseley, it is true, put forward a theory of his own, after having so seriously assailed that of Mr. Forbes. He proved by experiment that a plate of lead, lying on an inclined plane, and subject to alternations of heat and cold, gradually creeps down the plane, and with force sufficient to draw out nails if it had been secured by them to the plane. From this he was led to the opinion that a glacier under changes of temperature, must, in like manner, creep down its sloping bed, in consequence of the alternate expansion and contraction that must ensue. But he seems to have overlooked the fact revealed by some of Agassiz' experiments, that the body of a glacier does not share the changes of temperature that prevail on its surface. The possible limits, therefore, between which the temperature of a glacier can vary, are too slight to afford sufficient expansion even to a substance so expansible as ice.* Moreover, as has been well pointed out by Mr. Crose, of the English Geological Survey, "it follows, that a glacier, instead of moving more rapidly" (as in the case) "during summer than in winter, should, according to Mr. Moseley's theory, have no motion in summer whatever,"†—the range of temperature attributed to the glacier being between limits absolutely incapable of effecting the expansion of the ice in the smallest degree."‡

This fourth theory of glacier motion having been disposed of, the field was left comparatively clear, but for some time no competitor appeared to claim the dangerous honor. Faraday's discovery of regelation seemed to suggest a method of accounting, in some degree, for the continuity of the mass during its motion. He found that two

*The co-efficient of the expansion of ice is .0002856' for 1° Fah. It is, therefore, twice as dilatable as lead, and more so than any other known solid body.

†*L. E. & D. Philo. Mag.*, Sept., 1870. ‡*L. E. & D. Philo. Mag.*, 4th Series. Vol. x. p. 303.

pieces of ice *in a melting state*, if brought together, unite and become one. It was therefore suggested by Tyndall, that this newly discovered property of ice might be made to supersede the necessity of assuming, with Forbes, a plasticity, of which there was no proof, in order to account for the changes of form exhibited by the glacier in the course of its progress. Tyndall argued, that the ice might be broken into thousands of fragments, and that these would, under the pressure, again unite and form a single mass, adapting itself in this way to any new shape that might be requisite. By this means he endeavored to explain the passage of the Mer de Glace, which at the junction of its tributary stream is 2,597 yards wide, through the narrow gorge of Trilaporte, the width of which is only 893 yards.

But this glacial theory, if such it can be called, leaves the subject in even a worse position than did the viscous theory of Forbes, inasmuch as it supplies no moving force to account for the motion of the ice. Granted, that the ice moves and breaks, regelation may then account for cementation of the fragments into one mass. But by denying the plasticity of ice, the very possibility of its motion is destroyed. Canon Moseley has shown* that a solid body, such as glacier ice, would show no tendency to flow down the slope of the Mer de Glace, but would stand as firmly on its base, unless urged by a pressure from behind, as would a column of ice of one square foot in area, and of the same height as the glacier. If then the ice breaks, it is not plastic enough to flow, and if it is not plastic enough to flow under the influence of gravitation, it must be urged on by some other force, sufficient to overcome its high unit of shear. What that force is, the theory in question does not suggest. If put forward as a help to the viscous theory, it proves a dangerous ally. Regelation can not occur without antecedent fracture, and fracture excludes the fundamental assumption of the viscous theory.

Moreover, regelation does not occur unless the ice is in a melting state, or at 32° (F.) of temperature, whereas a glacier is more solid during the winter, when the thermometer ranges below the freezing point, than in the summer, when the ice is comparatively soft and thawing over its whole surface. The fractures therefore produced by the movement of the ice in winter should not close until the warmth of spring has again raised the temperature of the ice to regelation point, or 32° (F.)

The experiments by which Prof. Tyndall has endeavored to prove that ice can change its form by means of its property of regelation—beautiful as they no doubt are—lie open to an objection which renders them irrelevant. He has compressed snow under hydraulic power,

* *Proceedings of the British Naturalists' Society*, for 1869.

so that when turned out it had become a mass of perfectly clear ice—an effect, as he urges, due to its having regealed when the molecules were brought very closely together. In the case of a snowball made by the hands of a boy, this explanation is no doubt true, for the pressure is small; but when the force of the hydraulic press is brought into use, can Prof. Tyndall assert that the snow did not wholly, or in great part, melt in consequence of the lowering of its congelation point, and freeze again on the removal of the pressure? If so, the regelation to which he appeals is quite a different process from that of Faraday—occuring below, instead of at the freezing point; under great, instead of little external pressure; and throughout the mass, instead of only at the surface. Logically, therefore, it seems as if Prof. Tyndall, in making the suggestion, with a view, apparently, to support the Viscous Theory, has cut away from under the theory the very ground upon which it has previously maintained its foothold. It is, manifestly, impossible to hold at the same time both Forbes' theory and Tyndall's explanation of it.

It should be borne in mind, that all writers who seek to explain the motion of glacier ice, by a resort to forces sufficient to overcome this length unit of shear, are bound to include in their explanation a solution of the difficulty, that the swiftest movement is found in the middle and at the surface. In seeking such a force in the weight of the ice itself, or in that component of the weight, which acts horizontally, they are met by the fact, that at the surface, where the movement is swiftest, the weight is least; in other words, the greatest result ensues when the smallest force is employed. The horizontal component of the weight of the first foot in depth, on a slope so low as that of the Mere de Glace, is almost nothing, while the shearing force of the ice is as great there as at any point of the glacier, supposing it to be in a frozen state. It is impossible, therefore, that the mere weight of the ice can supply any motive power sufficient to shear the upper layers, whatever it may be able to effect at greater depth in the mass.

From this difficulty, however, those are free who attempt to account for the motion, not by introducing a force of high intensity to overcome the full shearing force of the ice, but by resorting to some means of undermining that resistance to such a degree, that the horizontal component of gravity in the glacier may be sufficient of itself to produce the whole movement observed. There has been, therefore, of late years, a disposition to work in this direction for a solution of the problem, and to seek a clue to it in some of the less obvious properties of ice. The further consideration of this will be the subject of the second part of this paper.

Review of the Development of Natural History as a Science.

By W. W. Calkins.

Said the great, the lamented Agassiz: "I have devoted my whole life to the study of Nature, and yet a single sentence may express all that I have done." This confession, coming from one who occupied the very highest rank among the learned, and who desired no greater epitaph than that of Teacher, reveals to us the simplicity and grandeur of the man. It suggests that the grace of modesty might be cultivated by most people with great propriety.

Since man was first created, he has been engaged in studying the world of animate and inanimate objects around him. From the time when Adam investigated the properties of a certain apple in the garden of Eden, our race has been employed in the constant endeavor to account for its own existence as well as that of other objects, by studying the diverse plans underlying the whole. As the first rude efforts seem to us like childish displays, so, when the present era shall become antiquity, our attainments in knowledge will no doubt appear small indeed, in comparison with the advances that shall mark the future age.

For two thousand years natural history has occupied a prominent place among the sciences. Aristotle was the first prominent naturalist, and the founder of the science. As evidence of this we have his "History of Animals," a work which contains the full results of ancient learning in this department, and surprises us by its minuteness of detail and the knowledge of the subject which it evinces. One other fact is also worthy of notice, that, considering the boasted superiority of our present civilization, does not reflect favorably upon our system of education. In Aristotle's time, two thousand years ago, text-books of natural history were in common use, and the study was pursued with vigor, while we are still without elementary works of this kind adapted to the young beginner. Therefore, the knowledge on this subject to be acquired in our schools is limited. We are, however, gradually working up to the point where the systematic study of natural history in the school will be indispensable and popular.

After eighteen hundred years, Linnæus resumed the work where Aristotle left it, and until he appeared as the lawgiver of science, we find that very little progress had been made in the study of natural history. Pliny added but little to what had been done by Aristotle. An intellectual darkness, hanging like a pall over the middle ages, followed the enlightened period of Roman and Grecian history, and gave us nothing. The sixteenth century witnessed a temporary revival in this and other branches of learning. The minds of men were then chiefly occupied in contemplating the policy and achievements of those great military heroes, the emperor Charles V., Frances IV., Philip II., and Henry IV., while the religious tendencies of the age found expression in Luther and the Reformation. The naturalists of this century were mainly occupied in studying local species, and disputing over ancient authors; therefore, their labor did but little good beyond keeping alive some interest in the study. The seventeenth century witnessed remarkable advances in general knowledge, but men had not yet ceased wondering over the successful revolt of the Netherlands, and the brilliant military careers of Gustavus Adolphus, Wallenstein, and Tilly.

In an age when war formed the chief occupation of men, and the profession of arms furnished almost the only avenues to distinction, it is no marvel that learning was neglected, or cultivated merely by the few. It was reserved, then, for Linnæus, in the last century, to break the spell that had for so many ages retarded the development of natural science, and strike the key-note that aroused the scholars of Europe from their lethargy. Aristotle had given us genera and species. He had divided the animal kingdom into the *Enaima* and *Anaima*, or blooded and bloodless animals. But he failed to provide any well defined system of classification, by separating animals into their natural groups; or to describe them, except in the common language of the day. Linnæus, beginning where Aristotle left off, established, in addition to genera and species, classes and orders. He divided the animal kingdom into six classes: Mammalia, Birds, Reptiles, Fishes, Insects, and Worms. But defects were discovered in this grouping. The class Mammalia he at first called the *Quadrupedia*, meaning four-legged, fur-bearing animals, bringing forth living young, thus excluding a division of mammalia, the *Cetaceans*, or whales, etc.

This classification of Linnæus at once aroused the attention and provoked the criticism of naturalists. The result was salutary. The defects of the new system were pointed out, and the important principle of a classification founded upon internal structure—by which animals are grouped upon common structural characters—was established. Linnæus, in his *Systema Naturæ*, corrects many of his previous errors. The active study of natural history led to many other classifications besides that of Linnæus; to him, however, belongs the credit of awakening inquiry in this direction, and of making the first attempt at a comprehensive system of grouping, that should embrace all animals. The magnitude of the task will be appreciated, when we consider the confusion and ignorance then prevailing in the science, and the vast extent and variety of species. These now number two hundred and thirty thousand.

But Linnæus did more. Prior to his time, research, confined mainly to continental Europe, had, as I have already hinted, been carried on in a limited and desultory manner. Each naturalist had studied his own immediate neighborhood or province, describing the species he found in the vernacular tongue. From want of communication, naturalists were but little acquainted with each other's labors. It became necessary to have a common scientific language and mode of expression that should be intelligible to all scholars, and at the same time embrace the elements of simplicity and adaptability. The binomial system, devised by Linnæus, contained exactly these elements, and the strongest proof we have of this fact, was its approval and adoption by all naturalists. The confusion that had before existed on account of the different names and languages employed, was now relieved by the use of one language—the Latin.

This achievement, while it placed Linnæus in the front rank of investigators, gave an unusual impetus to the study of natural history. We find, however, that Linnæus' classification did not meet with the same success. Its defects did not escape criticism from Lamarck, Ehrenberg, Von Baer, Cuvier, and other great naturalists. Had we time, it would be interesting to review in detail the labors of these scientists of the eighteenth and nineteenth centuries, and observe how slowly, step by step, the truths of science were discovered and established. Each contributed, more or less, to the final result. But all, with the exception of Cuvier, failed to reach the grand principles of classification.

It was Cuvier, then, who so far unlocked the secrets of creation, as to discover the plans upon which all animals are built. When he announced his theory, dividing the whole animal kingdom into four classes: Radiates, Mollusks, Articulates, and Vertebrates, the scientific world stood amazed, as though a revelation had been made from Heaven. Cuvier's discoveries were, however, the legitimate product of intelligent thought and research. The founder of comparative anatomy was not one who skimmed over the surface of things. Others had studied external and specific characters; Cuvier went deeper. He examined the internal organization and relations of animals. He tells us that *comparison* was the secret of his success. The result embodied the four plans of creation above mentioned. These divisions he based on certain characters entering into the structure of animals.

We hardly know which to admire most, this discovery, or the system of comparative anatomy, resulting from its application. Both may be considered as eras in the study of the sciences. Neither were received at first with absolute credit. The first met with much opposition, but time has fully verified the conclusions of Cuvier. The system was too short and simple for those naturalists, who, like some at the present day, have such a fondness for classification, that they overlook great natural laws underlying the construction of animals, and fancying they see in some peculiarity or abnormal form a new species or principle, forthwith make divisions and subdivisions *ad infinitum.*

The views of Cuvier, which have withstood successful criticism for nearly three quarters of a century, lead us to draw the following conclusions: *First*, that Cuvier's four classes embrace all known animals; *Second*, that there is thought and harmonious law as the basis of all, the whole directed by one will—the Creator; and *Third*, that the numerous divisions of the four great groups mentioned, such as classes, orders, families, genera, species, and the subdivisions of these, to be of value, should be formed in accordance with characters expressed in nature. Otherwise, they are artificial distinctions, tending to lead us away from what we seek, and that which is the basis of all science—the *truth*.

Another great discovery, hardly less important than those mentioned, was that of Von Baer, in embryology, *i. e.*, the fact that all animals are produced from the egg, and though alike at first, grow to maturity on four different plans. Embryology is yet in its infancy. Agassiz made some of his greatest discoveries in this science, and it furnishes one of the most attractive and promising fields open to the explorer.

I have now pointed out some of the great epochs of natural history, barely stating prominent facts, omitting, from necessity, details connected with its growth, and names that have become distinguished in its development. Its history, for fifty years, has been that of rapid progress. In common with all other branches of knowledge, it has had its eras of brilliant achievements. But the latter part of the last, and the beginning of the present century, were particularly marked by great discoveries. It has been said, that after revolutions the intellectual vigor of nations is always quickened. It was so in Germany, France and the United States.

This country has been honored in being the adopted home of one man, who, by his labors and discoveries in natural history, his simplicity and greatness of soul, has done more for the science than any man since Cuvier. The present century has produced hosts of distinguished naturalists, who have labored successfully in their particular departments, but Agassiz, at the time of his death, probably, ranked first among living contemporaries. In conclusion, I have only to remark, that this and other of the sciences, entering as they do into our thoughts, occupations and lives, should, as far as possible, be popularized, by providing liberally for their support and study in all our schools and scientific institutions.

The Zoological Society of Cincinnati.

This organization having become a fixed fact, and the practical realization of its plans in a measure accomplished, we feel sure that all lovers of science will join in acknowledgments to those worthy gentlemen, through whose liberality, energy, and public spirit, all difficulties in the way of its creation have been overcome, and the foundation laid for a permanent institution, which may, at no distant day, rival the older enterprises of Europe.

The true way to popularize science, is to bring the objects of scientific investigation within the reach of the many, and any enterprise having this for its aim, deserves the cordial good-will and support of the community. Scientific museums, art galleries, industrial expositions, and zoological collections, open to the public on easy terms, do as much, or possibly more, for the education of the people at large, than public libraries. Perhaps it is hardly proper to institute such a comparison, inasmuch as these supplement the schools and libraries in affording an opportunity to verify the results of book-training by actual observation. The mode in which they contribute to the general education of the people, however, is by exciting an interest in the objects of nature, that by reflex action naturally leads the mind to inquire into the relations of those objects, and the laws by which they are governed. But to the young, who are engaged in the study of science in our schools and colleges, these institutions are of more direct and living importance. They afford material for object teaching, which no private or public institution of learning could gather or maintain. Each lesson—each newly acquired fact, is thus stamped upon the mind of youth with a vivid and ineffaceable reality which thenceforth becomes part of the mental constitution. By such modes are to be trained the minds of our youth, if they would be able to grapple with the scientific problems of the future. The intellect of to-day demands *facts*—sifted and tried—as the basis of all speculation; and the future demand will be even more inexorable. It therefore behooves us to provide liberally for that demand; and, as a step in this direction, the creation of a zoological garden with the object, as declared in the Constitution of the Society, of promoting the "study and dissemination of a knowledge of the nature and habits of creatures of the animal kingdom," is one which entitled its projectors to the gratitude of every citizen who appreciates the value of education.

We are enabled, through the kindness of the officers of the Society, to present a brief history of its origin and organization. Prior to any public suggestion of the matter, Mr. Andrew Erkenbrecher, President of the Acclimatization Society, had, through the Secretary of that body, corresponded with the celebrated naturalist, Dr. A. E. Brehm, with a view of obtaining an estimate of the cost of a Zoological Garden established upon European models, requesting statistics in regard to those already established in Europe, and all other available information pertinent to the subject.

The reply of the distinguished scientist, containing many valuable suggestions, and accompanied by the annual reports and statements of several European societies, was laid before a meeting of the Acclimatization Society, held at the rooms of the Cincinnati Board of Trade, June 19th, 1873. At this meeting, a resolution, offered by Mr. John Simpkinson, was adopted, providing for a committee charged with the duty of digesting a plan of operations. The committee, consisting of Messrs. Andrew Erkenbrecher, John Simpkinson, and George H. Knight, subsequently called a meeting of citizens understood to be favorable to the proposed enterprise, for Monday, June 30, 1873, at which Dr. Lilienthal, Mr. Simpkinson, and others, delivered spirited addresses, a large sum of money was subscribed, and resolutions were adopted providing for the incorporation of a Society whose capital stock should be $300,000. In conformity with this action, Messrs. Simpkinson, Erkenbrecher, C. Oskamp, Knight, and A. Tenner, subscribed articles of incorporation under the name of the "Zoological Society of Cincinnati," which were duly filed and recorded, according to law, on the 11th day of July, 1873. The first meeting of the newly formed Society, was held at the Board of Trade rooms, on July 28th, and the following named gentlemen elected Directors to manage its affairs, viz.: Joseph Longworth, J. Simpkinson, A. Erkenbrecher, A. Pfirmann, John A. Mohlenhoff, Charles P. Taft, John Shillito, George K. Shoenberger and Julius Dexter. The Board of Directors thus constituted, immediately organized and elected the following named officers, viz.:

Joseph Longworth, President; J. Simpkinson, Vice-President; Clemens Oskamp, Treasurer; Charles P. Taft, Recording Secretary; and A. Tenner, Corresponding Secretary. Messrs. Julius Dexter, Charles P. Taft, and A. Tenner, were appointed a committee to draft a constitution and by-laws for the Society, who submitted the results of their labor at a meeting called for the purpose, August 15th, and the same were finally adopted by the Society, at the first regular annual meeting of stockholders thereafter, on January 5th, 1874. From the constitution, as adopted, we make the following extracts:

"SEC. 1. The name of the Society shall be 'The Zoological Society of Cincinnati.'

"SEC. II. The object of the Society shall be the establishment and maintenance of a Zoological Garden at Cincinnati, and the study and dissemination of knowledge of the nature and habits of creatures of the animal kingdom.

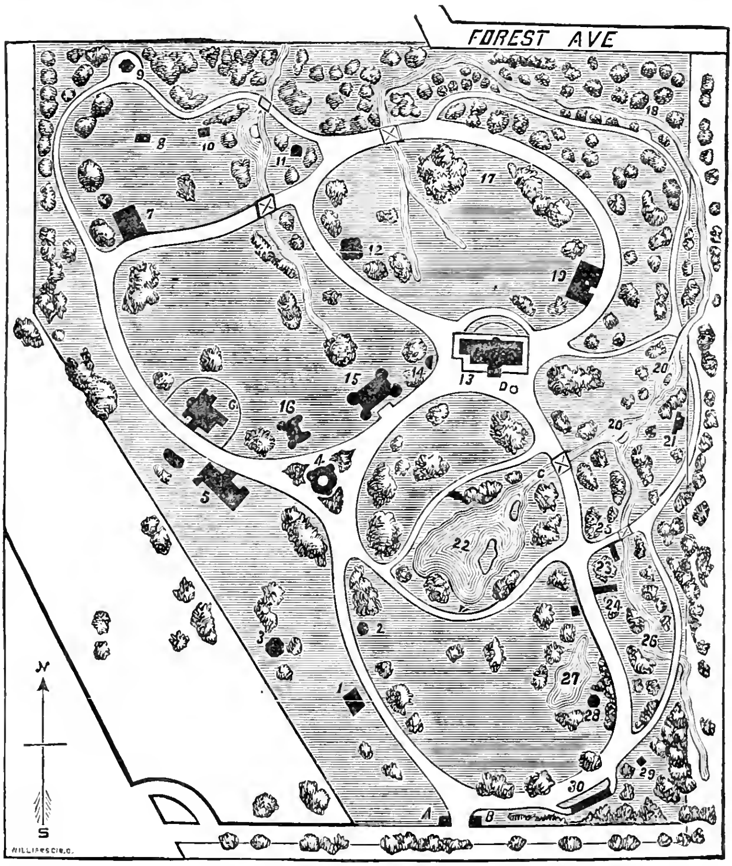
"SEC. XVI. Stockholders shall be entitled to receive for each share of stock up to the number of five, twenty single tickets of admission each year, or one season ticket. All season tickets shall be issued in the name of a particular person, which shall be registered, and any season ticket presented by any other person than the one to whom it is issued, shall be forfeited," etc.

At the same meeting, a new election of officers being required by the constitution annually, Messrs. Longworth, Shoenberger, Dexter, Taft, Horton, Simpkinson, Erkenbrecher, Mohlenhoff, and Pfirmann, were elected directors, to serve for the terms of one, two, and three years, respectively; and upon the organization of the Board of Directors, the following named gentlemen were elected officers for the year 1874, viz.: Geo. K. Shoenberger, President; A. Erkenbrecher, Vice-President; Charles P. Taft, Secretary; Clemens Oskamp, Treasurer; and A. Tenner, Corresponding Secretary.

On April 27, 1874, Julius Dexter was elected President of the Association, vice Geo. K. Shoenberger, resigned; and subsequently, C. Oskamp, was elected a director, vice S. D. Horton, resigned.

As will be seen from the foregoing summary of its history and organization, the Zoological Society is a strictly private enterprise, not in any way dependent upon municipal aid for its existence or success. Many years, and a large expenditure of money, will be required for the full development of the plans adopted, but with the means already secured, the society will be enabled so far to complete the improvement of the site selected, as to open its Garden to the inspection of the public in the summer of 1875, with a collection of animals larger than is possessed by any other society in this country.

The zoological gardens of Europe are conducted upon the plan adopted for this one, and receive, in the way of donations from various sources, a large part of their collections, and, in many cases, the buildings for their shelter. While ours may not expect to receive aid of this nature to the same extent, yet there is little doubt that the liberal sentiment already displayed toward the enterprise will continue and increase to a degree which will, in a few years, abundantly relieve it



from any embarrassments attending its foundation. Many of the animals now in its collection, together with trees and shrubbery for the adornment of the grounds, have been contributed by friends of the enterprise, and many more are promised.

The Garden, containing 69 acres, will, when completed, be a delightful park, where hill and vale, grassy lawn and blue lakelet, flashing cascade and rustic bridge, will alternate in attracting the eye, forming vistas of varied beauty, as seen amid grouping foliage. The collection of animals to be displayed, brought together from all parts of the world, will be sheltered and cared for in and about ornamental buildings, erected in varied and suggestive styles of architecture—Gothic, Norman, Oriental, etc. Much of the ground work is completed, and the remainder is being rapidly pushed forward, with the expectation of finishing the grading of avenues and the planting of trees by the summer of 1875. The shelter-houses will require a longer time for their completion.

The illustration presented herewith, shows the ground-plan of the Garden, with location of avenues, lakes, bridges, cascades, and shelter-houses. By reference to the numbers, the exact positions will be more readily understood from the following list:

1. Buffalo house.
2. Prairie dog house.
3. Cattle inclosure.
4. Aviary.
5. Elephant and hippopotamus.
6. Camel, giraffe and antelope.
7. Kangaroo inclosure.
8. Deer house.
9. Tower.
10. Small deer house.
11. Large bear pit.
12. Eagle inclosure (house for birds of prey).
13. Restaurant.
14. Orchestra stand.
15. Monkey house.
16. Ostrich house.
17. Chamois.
18. Wolf house.
19. Carnivorary and winter house.
20. Beaver pond.
21. Owl castle and small bear pit.
22. Large lake (water fowl).
23. Goat inclosure.
24. Sheep inclosure.
25. Wombat house.
26. Otter pond.
27. Seal pond.
28. Coney burrow.
29. Fox house.
30. Fowl house.

A. Large entrance house.
B. Small entrance house.
C. Large cascade and rustic bridge.
D. Small fountain in front of restaurant.

Places for the following houses have not yet been assigned:

Swine house.
House for different small climbing animals.
Squirrel house.
Crane house.
Doves' cote.
Llama.

Acidaspis O'Nealli—(S. A. Miller).

Body medium size, subelliptical in outline, only slightly convex, tuberculated.

Cephalic shield a little more than twice as wide as long, somewhat semi-circular, margin consisting of three subequal arcs and produced into rather strong spines that extend obliquely outward; lateral arcs spinous; eyes prominent, directed outward. Glabella twice as long as wide, with two lateral lobes on each side, the anterior ones somewhat oval in outline, the posterior ones situated between the eyes, and the central lobe somewhat circular in outline; glabella terminating posteriorly in a short spine, which projects over the middle lobe of the trilobite to the fifth segment; neck furrow rather distinctly marked.

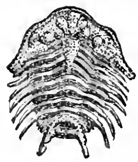


Fig. 9.—*Acidaspis O'Nealli.*

Thorax about twice as long as the cephalic shield, and exclusive of the produced extremities of the pleuræ, a little longer than wide; consisting of eight segments; middle lobe strongly convex; lateral lobes depressed; pleuræ terminating in rather long mucronate spines directed outward and backward, posterior ones a little longer, and directed more nearly backward.

Pygidium small, axis short, sides flat, except a ridge that extends obliquely backward and outward from the anterior segment of the mesial lobe across each, and terminates in a prominent, rounded, diverging spine. Between these two projecting spines the specimen shows no spines, though it may have had four minute ones of about equal size. There are apparently two minute spines on each side of these projecting spines.

Length of specimen, exclusive of spines, 0.65 inch; breadth, 0.45 inch; breadth between the eyes, 0.20 inch.

The specific name is given in honor of the collector, J. Kelly O'Neall, of Lebanon, Ohio, who found it in the upper part of the Cincinnat Group, near Lebanon.

EDITORIAL MISCELLANY.

The Cincinnati Museum of Science and Art.—Mr. Henry Probasco, to whose taste and munificence the city of Cincinnati already owes so much, recently, upon two public occasions, has announced the fact that he and other gentlemen of wealth have in contemplation the details of a plan for establishing, in this city, an institution similar in its general design to the South Kensington Museum, of London, which is to be in its nature educational, devoted to the culture of science and art among the people at large.

The importance of such an institution in the Queen City of the West, already recognized as a growing center of musical and artistic culture, can hardly be overestimated, if the noble project is so consummated as to subserve the interests of education in the highest and best sense.

The cultivation of the mind through the eye, is universally recognized as one of the most efficacious modes of modern education; and the collection, in one convenient building, of objects for illustrative reference in the various departments of natural science and the fine arts, can not but exercise a most important influence upon the general culture of the community.

Something has been already accomplished in this direction—so far, at least, as relates to Natural History—by a society of some years' existence in this city, composed of persons more especially devoted to technical scientific culture. This organization, known as the "Cincinnati Society of Natural History," has already accumulated a valuable collection of objects illustrating the various departments of Natural History and pre-historic Archæology, which needs only a proper and secure place for its deposit, to be very largely increased by donations, now withheld because of the insufficiency and insecurity of the present rooms.

The same remarks apply with little modification to the fine library and collection of antiquities of the "Historical Society of Ohio." These societies, with their valuable treasures, are quartered in small garret-rooms of the College Building, on Walnut street, practically inaccessible to the general public, and exposed to all exigencies of fire.

Both of these societies, composed of men of exceptional culture, deeply interested in promoting the special objects of their association, could be made valuable auxiliaries in perfecting the plan announced by Mr. Probasco. They might be united as departments of an institute which should include any others contemplated by the founders; and the stimulus thus afforded to nuclei already in existence, would be productive of results far exceeding those attainable in any other way. A live and permanent interest would thus be maintained in each department, under the control of persons devoted to the particular objects of its creation; and a fire-proof and convenient building for their exhibition would attract to such collections a vast number of valuable and interesting objects now buried in comparatively useless private cabinets.

—In this connection, we may refer to the AMERICAN MUSEUM OF NATURAL HISTORY recently established in the old arsenal in Central

Park, New York, to which Miss Catherine Wolfe has lately presented a conchological collection, numbering 50,000 specimens, costing $10,000.

The municipal government of that city is now erecting a magnificent building for this museum, of very large proportions, for the first section of which—one eighth of the ultimate structure—the sum of half a million dollars has been appropriated. The city is only to erect the buildings, the cost of collecting and preserving the specimens being defrayed by a private society. The success attending the opening of this museum to the public is said to have been something remarkable, no less than ten thousand people visiting it daily. The departments represented in its splendid collection are such, in variety and classification, as to offer invaluable opportunities for special investigation, and are already attracting scientific men from distant parts of the country.

The Zoological department comprises the collections of Prince Maximilian, of Neurvied, M. Vedrey, and M. Vereaux, containing nearly 4,000 specimens of mounted mammals, birds, reptiles and fishes, including skeleton forms.

The collection of North American Birds contains 2,500 specimens; Lepidoptera are represented by 10,000 specimens; Beetles aad Insects by 4,000 specimens, besides a collection of foreign insects as yet unclassified. Mollusca are well represented by various collections, including the magnificent donation of Miss Wolfe, which occupies an entire story, accompanied as it is by a rare conchological library of 10,000 volumes.

The Entomological department comprises 8,000 specimens of American Coleoptera, representing 3,000 species; also, sixteen skeletons of the gigantic fossil Moas, of New Zealand. Mineralogy is represented by 7,000 cabinet specimens. The museum also includes the fine collection of pre-historic remains, belonging to Dr. Davis, formerly of Ohio, which contains many typical and rare forms of utensils used by the ancient Mound-Builders of the Ohio and Mississippi valleys.

Besides those mentioned, there are other collections which will be classified and arranged when the society occupies its new building It is the intention of the projectors to establish a system of scientific lectures by persons eminent in the various departments of science, and to keep the collections open to the public on easy terms.

—While upon this subject it may not be uninteresting to refer, also, to the magnificent museum of the Academy of Natural Sciences of Philadelphia. This organization, which assumed the shape of a legal entity in 1812, was formed by persons, who, prior to that time, met at each other's houses for the purpose of mutual instruction in Natural History, and of devising the plan of the present institution.

The museum was opened in 1828, and has, since 1841, published its proceedings in an interesting and valuable series. One of the most important features of this museum, is the splendid collection of human Crania, begun by the late Dr. S. G. Morton, and said to be the finest in existence. This collection, increased by various subsequent additions, now contains upward of 1,300 specimens, including many of great rarity and value. Among the more ancient races represented, are the Phœnician, Egyptian, Greek, Roman, Hindoo, Peruvian of the Inca race, ancient Peruvian, Aztec, Otomie, Pames, Chichimec, Hispano-Mexican, etc.; besides a full collection of specimens of the early and more recent tribes of Indians of the United States and Canadas, Caribs and Brazilians. In the collection of mummies are many specimens of Egyptian art; also, two natural mummies, or desiccated bodies, from the arid salt-desert of Atacama, lying between Peru and Chili, supposed, by Dr. Morton, to be representatives of the long extinct race whose profiles are sometimes figured in Centra American sculpture. Perhaps no collection in the world affords the ethnologist so good an opportunity for comparative study.

American Archæology.—It is the desire and purpose of the editors, in response to a general and increasing interest in the subject, to devote more attention than hitherto, to the inquiry concerning the ethnical history of the pre-historic races of this country, as a legitimate and important branch of scientific investigation. In this view, communications from investigators, containing new and interesting matter, will be given due space and consideration. It is highly important, however, that the facts should be presented with accuracy and detail. The subject has been already sufficiently embarrassed by speculations founded upon inaccurate or insufficient observations; and phlogistic theorizing must give place to experimental methods, ere we can hope to advance our knowledge in the true direction.

While, therefore, soliciting information from our readers and correspondents who have given the subject attention, we would impress upon them the importance of holding the imagination in check until all the *facts* have been properly exhausted. It often happens, in practical investigations of this nature, that the result is rendered in a measure valueless, by the ommission to note fully the circumstances under which a given examination is made, or the precise relation of objects recovered to surrounding conditions. For the same reason, the student, who seeks knowledge by a comparative study of remains gathered in museums, is often embarrassed, and his labor rendered vain, by the absence of similar information.

The value of such details is indicated in the following extract from a letter recently received from Prof. Henry, the distinguished head of the Smithsonian Institution, at Washington.

"It is our object to trace the development of a particular idea, or the use of a given material, over the entire extent of its range, so as to judge of the comparative relationships and affinities of the people in different sections of the country. The concurrent use of a certain material, such as copper, over a wide extent of country, while the material itself is confined to a single locality, has an important bearing on the question of the domestic commerce of the aborigines; while the reproduction, in different materials, of some particular form, over an extended region, indicates, to a certain extent, a common origin, or, at least, a close intercourse."

The importance of such careful and detailed observation pertains to all archæological inquiry; but it is doubly necessary in the present case, when we consider, what we have before remarked in a similar connection, namely: that the page here presented to our scrutiny is a palimpsest from which the characters inscribed by later, and perhaps inferior, races, are to be eliminated before we can hope to decipher the record of the true autocthones.

Every circumstance bearing upon the actual or relative age of remains, is, therefore, of the highest importance. Depth and character of soil; excavation of ravines; change in line of water courses; type of mound structures, and their position in respect to river-terrace formations; annular growth of trees; thickness of vegetable deposits; material and style of minor relics—all are matters to which the closest observation should be given, together with others which will suggest themselves to the practical archæologist.

Ancient Burial Custom.—Prof. E. W. Claypole, of Antioch College, Yellow Springs, Ohio, sends us a brief note of the discovery, in his neighborhood, of a human skeleton, somewhat decayed, in a gravel bank, about a foot or so beneath the surface, with a sheet of mica covering the face of the skull; and suggests the inquiry: whether the practice of placing mica over the face was common in burials among the early settlers of Ohio.

Presumptively, upon the information furnished, the remains are aboriginal—the presence of mica, under similar circumstances, being a feature not uncommon in burials of the ancient and perhaps the more recent aborigines of the United States. The mineral is often discovered in the earth-mounds, and in the vicinity of ancient works in nearly every section where there are remains of the Mound-Builders. No original deposit exists within the State of Ohio. Mr. Jones, in his "Antiquities of the Southern Indians," alludes to the frequent occurrence of "isinglass mirrors," or discs of mica, not only in the ancient graves and mounds, but also upon the sites of old Indian villages and in relic-beds, in Georgia. Squier and Davis bear similar testimony concerning the tumuli of Ohio.

Prof. Kerr, of the Geological Survey of North Carolina, from the evidences of ancient mica-mining operations, disclosed in clearing out pits formerly supposed to have been excavated by De Soto, believes the source of supply resorted to by the Mound-Builders, for this mineral, existed in the mountainous regions of his State. Our markets are now chiefly supplied from that locality.

Mound Explorations.—Prof. R. D. Smith, Principal of the Columbia Athenæum, Maury county, Tennessee, sends us the following interesting account of a mound exploration recently made by him, assisted by Dr. W. A. Smith of the same institution:

"Since my last letter to you we have opened the large mound, of which I have before spoken, situated four or five miles north of this place (Columbia). The mound is a four-sided truncated pyramid, say 80 by 30 feet at the base, with a level summit about 50 by 20 feet in area, and is about 25 feet in perpendicular altitude. Forty years ago, large trees, two and two and a half feet in diameter, grew upon this mound, but no trace of them now remains. Before the war the level top of the mound was used by an old negro as a garden spot. At present it is covered with a thick growth of cane, four to six feet high.

"We made an opening in the top of the mound in the center, say nine feet in diameter. *The first three and a half feet of excavation was through soil, evidently made from decaying vegetable matter since its original construction by the Mound-Builders.* (This may assist you in determining the age.) After passing through this soil the "made earth" could be easily distinguished, and it was here that the only "find" was discovered. Near the center of the mound we found an opening in the top, about twenty inches in diameter, and about twelve inches deep, in the form of a pot, made by excavating the earth and plastering the hole with mud, then partially burning it. Within this receptacle we found pieces of charcoal—some of them six inches long. This I take to be good evidence of the original height of the mound, and that all of the earth above has been formed since; and, also, that it was a sacrificial mound. The excavation was continued to the level of the surrounding country, but without further results."

—We have italicised the statement relative to the deposit of vegetable matter upon the original surface, for the purpose of directing attention thereto, and eliciting inquiry as to the average rate of such deposit in the ordinary forests. Although the accumulation of decayed vegetation, year by year, is perhaps hardly susceptible of such accurate measurement as the alluvium of rivers, which, like the Nile, are subject to periodic overflow, yet data could perhaps be gathered from which approximate results might be ascertained.

—The same diligent observers send us also an account of an exploration made a week or two previous, which we reproduce as bearing upon the inquiry suggested by Prof. Claypole:

"The mound opened is situated seven miles south of Columbia, about midway between the Pulaski and Campbellsville roads, near Bigbyville, upon a hill-side commanding one of the most beautiful prospects in the country. It would measure about thirty feet in diameter at the base, and about seven feet in perpendicular height. All that we found was a portion of one skeleton—some of the feet bones, portion of a thigh bone, and a fragment of an arm. We could trace other portions, but they were too much decomposed to be taken out. *On the face and both hands were plates of mica*—one of which I send you. Near one of the hands were two teeth of some animal; one crumbled upon exposure to the air, the other is nearly perfect, which please accept, and tell us what it was used for. Both were exactly alike. Could not find any traces of pottery, or implements of any kind. From what I can learn, this section of country was not used by the Indians as a place of residence, but simply as a hunting ground—their regular camps being to the west of this, in Lawrence, Hickman, and other counties."

The tooth received was that of a bear. It was ground flat on opposite sides, on one of which were two small holes, drilled through into the nerve-cavity. The specimen was identical with those obtained recently by Dr. Hill, from the aboriginal graves upon Brighton Hill, near Cincinnati, and supposed to have been attached, by means of a string passing through these holes and the nerve-cavity, to the breast of the wearer, either as an emblem of prowess or badge of office.

The discovery of these teeth, prepared in precisely the same manner, at points so distant from each other, would seem to favor the latter supposition, inasmuch as such coincidence could hardly be accidental (as would be the case if worn to indicate the personal achievement of the wearer), and therefore presupposes a conventional signification common to widely separated tribes, which "indicates, to a certain extent, a common origin, or, at least, a close intercourse," especially when considered in connection with the practice of burial, of which mention has been made.

—The Missouri Mound.—Since going to press, we have received from Dr. S. H Headlee, of St. James, Missouri, an interesting letter concerning the mound near Springfield, described in the paper on "Sacrificial Mounds" in the foregoing pages of this issue, from which we extract the following:

"The mound you speak of is located in Greene county, in this State, about 12 or 14 miles north of Springfield. It is about 37° 20′ north latitude, and 16° west from Washington City. According to the local survey of the State, it is in Range 22, Town. 31. It is sixty feet high, its diameter at the base is 350 feet; at the top 130 feet. It is surrounded by a trench (except about 20 feet at the north), about 200 feet wide and 4 feet deep. How much this may have filled in the past is hard to determine. On the north-west there is a deeper excavation, about 200 feet across, and 6 or 7 feet deep. These trenches are where the materials came from to build the mound, as the rock and clay in the mound are the same as those that compose the top of the hill on which it is situated. The north side has an easy approach, with a great many large loose rock, which may have composed a stair way, but of this I am not positive. There are a great many rock in the mound, but whether they are put in regular layers or not, is hard to determine from an external survey. Some of them, especially toward the top, seem to be in layers; others appear to be loose. The rock is a vermicular sandstone. In the deep cut on the north-west corner are found numerous fossils, such as I have not been able to discover in any of the geological formations near. The formation near, in which there are any fossils, is the lower carboniferous, and all the specimens obtained have been either carbonate of lime or a silicate, but these are seemingly an oxide of iron. The inference is, that they have been brought there and left by the Mound-Builders or the worshipers that came after them, as this is evidently a sacrificial mound.

This mound is on the highest point on the highest hill, in a very hilly country, and which rises some three hundred feet above the valleys by which it is surrounded. It is situated in a rough, broken region, with plenty of water and timber around and near, but very little tillable land nearer than five miles. It is the only work of its kind in all the south-western portion of the State so far as I have any information. When my father settled in that country, forty years ago, the few remaining Indians could give no account of the mound or its builders; and it evidently does not belong to the present race of

American Indians. Although familiar with this mound from my boyhood days, when I would gaze on it with wonder not unmixed with awe—standing there all alone among the wild hills, the imperishable record of a dead and forgotten race--it never occurred to me to examine it with any accuracy, until last May, while on a visit to my father, and then I could only give the time to a surface survey. But it is my intention to visit that country again, between this and the coming spring, and institute a careful exploration, and if I should find anything of value to the inquiry into the habits and history of the long perished races on this continent, it will be a pleasure to me to confer with you, and submit the results to your consideration.

— MOLLUSCA.—W. W. Calkins, of Chicago, in a recent communication, states, that since the publication of his paper on "Land and Freshwater Shells of LaSalle county, Illinois," in a previous number of this Journal, he has identified the following species in addition to the one hundred and five enumerated in his catalogue: *Unio parvus*—(Barnes); *H. pulchella*—(Muller); and *H. costata*—(Muller), said to be a strongly ribbed variety of *H. pulchella*, and *Ancylus tardus*—(Say), which species he found in the Vermillion river, clinging to small stones. The variety *costata* are very distinctly marked. He observes that they have been found in other sections, and follows Binney in placing them as above.

—METEOROLOGY.—The following interesting summary of observations of atmospheric phenomena, obtained from the Signal Service observer at this point, should be read by all who would converse intelligently upon that all-absorbing topic—"the weather:"

The Atmosphere.—The circulation of the atmosphere around the earth bears a striking analogy to the waves of the ocean, except that the atmospheric waves are of vastly greater dimensions. It extends in height to the point where the two forces arising from the earth's rotation and the earth's attraction are about equal. The vapor of water contained in the atmosphere is the prime influence disturbing its equilibrium. This vapor absorbs heat and renders the air light, causing it to ascend. The earth's surface absorbing the greater portion of the sun's rays, the air is heated principally at the bottom, when it ascends and loses its heat by radiation most rapidly at the top. As this light, moist air ascends into the upper regions, where the temperature gradually becomes lower, the vapor of water of which it is largely composed condenses, and when the upward currents have no longer power sufficient to uphold this aqueous accumulation, it is precipitated in the form of rain, or snow. Dry air, on the other hand, by reason of its greater weight, has a tendency to sink downward and exert a pressure upon the earth. During the prevalence of a southerly or equatorial current of air we find, therefore, a low barometer and comparatively high temperature; while under a northerly or polar current the opposite holds true. In the one case the currents move from the warmer regions of the earth, passing over warm countries and great bodies of water, continually absorbing vapor, and in their upward movements forming clouds by condensation and finally rain. In the other case, the currents coming from the polar regions are cold and have a greater density, causing a high barometer, and correspondingly low temperature.

Storms.—Storms are more or less violent and extensive commotions of the atmosphere. As a general thing, they are accompanied by a fall of rain or snow, and ofttimes by thunder and lightning, although the storm area may extend beyond the area of rain or snow. Ascending currents of air naturally encounter less pressure, and in consequence the air expands, and in expanding cools at the rate of 38° for every two miles of ascent. The vapor which it contained at the earth's surface is carried with it, and the cold produced by expansion condenses a portion of this vapor into cloud. When cloud begins to form, the latent or inappreciable heat of the vapor is liberated, increasing the temperature of the air in the cloud, which expands in volume and continues to ascend as long as its temperature exceeds that of the surrounding air. By reason of the expansion of the air in the forming cloud, especially after rain begins to fall, the air spreads out in all directions above, while near the limits of the cloud, owing to its greater weight, it sinks downward, and a portion of it seeks the center of the upward current, the remainder flowing as a gentle wind outward from the limits of the cloud. In consequence of the air spreading out more rapidly above the cloud than it runs in below, storm areas extend with great rapidity, until they frequently attain a diameter of more than a thousand miles.

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THE CINCINNATI QUARTERLY

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Tineina of the Central United States.—By V. T. CHAMBERS.

Æsyle, gen. nov.

Though the species described below is very near *Lithocolletis,* I have felt compelled to erect for it this new genus. The neuration of the fore wings is exactly that of *Lithocolletis,* except that the marginal veins other than the first costal and first dorsal are very indistinct. That of the hind wings is nearer to that of *Gracilaria,* the subcostal proceeding almost straight to the apex, but being very faint. The discal (?) vein is furcate on the posterior margin, and the median (?) is short and simple; but the costal margin is not at all excised, rather in this respect resembling *Elachista* than either *Lithocolletis* or *Gracilaria.* The head of the single specimen before me is smooth, and from its appearance I think it never had a tuft, though as the vertex is a little denuded, it possibly may have had a small one; the form of the head and the antennæ are those of *Lithocolletis,* the antennæ not reaching the apex of the wings; the maxillary palpi, though small, are distinct, resembling those of some of the small species of *Gracilaria,* while the labial palpi are a little larger than in *Lithocolletis,* and smaller than in *Gracilaria,* with the second joint somewhat clavate, and the third more than half as long as the second, and pointed, thus resembling in form the palpi of a true *Gelechia* more than those of *Lithocolletis.* In the dead insect the maxillary palpi are porrected and the labial recurved, drooping a little. The tongue is small and sparingly scaled, and the cilia are about as in *Lithocolletis.*

A. fasciella (n. sp.)

Head and palpi silvery white, except a small brown spot on the outer surface of the second joint of the labial palpi at the tip; antennæ fuscous, paler toward the base. Legs white, with brown spots on the anterior surface of the first and second pair. The thorax is silvery white. The fore wings, as far as the basal one fourth, are pale or yellowish brown, margined with brown behind, then follows a wide, silvery white fascia; then a wide pale brown one margined with darker brown behind, extending to the middle of the wing, and followed by a second narrower white fascia; then follows another brownish band, also dark margined behind and followed by a third white one, which is narrower than the preceding ones; then follows another dark margined brown one; behind which is a fourth (narrow) white fascia, just before the tip, which is brown. There are thus four white fascia, separated by brown ones, and the base and tip of the wing are brown. The under surface is also brown; the brown fascia of the upper surface are tinged in some lights with pale golden. The second white fascia is a *little* oblique; the others are nearly straight. The fringes are silvery, a little flecked with brown at their base, where they adjoin the brown fascia. Abdomen brown above, silvery white beneath, and the apical tuft is silvery, tinged with golden.—*Al. ex.*, five sixteenths inch, Kentucky.

In a paper now in the hands of the Editors of the *Canadian Entomologist* for publication, I have described a species under the name of *Theisoa multifasciella*, which closely resembles this insect in ornamentation. The palpi of that species are about twice as long as in this species, and the colors are less showy and bright.

LITHOCOLLETIS—*L. symphoricarpœella* (n. sp.)

Brownish golden palpi of the general hue, but paler internally; face yellowish white; tuft, thorax and primaries brownish golden, deepening toward the apical part of the wings; there is a rather indistinct. whitish, median basal streak and two silvery white fascia, both internally dark margined, the first about the middle of the primaries, the other at the beginning of the cilia. Apex dusted with brown. There is a short, rather indistinct, oblique, white, costal streak close to the apex, and no hinder marginal line in the cilia. Under surface of the body brown, in some lights steel blue, with prismatic reflections. *Al. ex.*, $\frac{1}{4}$ inch, Kentucky. Larva cylindrical, mine tentiform, in the under side of leaves of the Indian currant or red waxberry (*Symphoricarpus vulgaris*). I have not found it in the allied snowberry.

L. Mariæella (n. sp.)

Face and palpi white, terminal joint of the palpi brownish externally; tuft orange yellow; thorax and primaries golden; antennæ white, annulate with brown; primaries with two white fascia, one about the basal fourth, the other about the middle, both distinctly dark margined internally; before the cilia, a costal and opposite dorsal white streak, nearly meeting on the median line, and dark margined internally; just before the apex, an oblique, very distinct white streak, sometimes extending almost across the wing. No hinder marginal line; cilia a little paler than the wing. *Al. ex.*, one fourth inch.

Three specimens received from Miss Mary E. Murtfeldt, of Kirkwood, St. Louis county, Mo., who informs me that they were bred from larvæ of the cylindrical group, making a tent mine on the under surface of leaves of the Indian currant or red waxberry (*Symphoricarpus vulgaris*). She has also sent me a specimen of the mined leaf. The mine is larger than that of the preceding species, *L. symphoricarpæella*, and so is the imago, and the two insects are not at all likely to be mistaken for each other. This species is much more likely to be mistaken, by the tyro, for *L. ornatella*, but is very readily distinguished in the larval state by the following characters: the larva of *L. ornatella* mines locust leaves, belongs to the flat group, and the mine is flat on the under and upper surface indifferently, and it leaves the mine to pupate; while this species has a cylindrical larva, which mines only the under surface, the mine being tentiform, and it pupates in a strong, white, roundish or oblong cocoon within the mine. The imago is less brilliant than that of *ornatella*, the tuft is larger, and orange or reddish orange, while that of *ornatella* is maroon brown, and the face of *ornatella* is brilliant metallic (like silver or polished steel, according to the light), while the face of this insect is white; the thorax and base of the wings of *ornatella* are rich maroon instead of golden, and there is a distinct, maroon brown hinder marginal line, which is wanting in this species. There are also other less striking differences. Miss Murtfeldt, in whose honor I have named this species, sends me the following notes of the mine and larva:

"Larva found Oct. 25, making a tentiform mine on under side of leaves of *Symphoricarpus vulgaris*. Length one fourth inch; diameter less than one sixteenth, cylindrical or subcylindrical, tapering slightly both ways from the middle segments. Head very small, flattened, polished, honey yellow; jaws edged with rose color. General color of the body translucent golden yellow, immaculate. Incisions quite deep, two or three fine hairs on each side of each segment. The mine is made quite spacious by the wrinkling together of the under cuticle of the leaf. The frass is collected in one end of the mine. The insect pupates inside its mine, inclosed in a strong, white, roundish or oblong cocoon, similar in appearence to, though not so dense as, the cocoon of *Chrysopa*. The chrysalis is elongate, pointed, with the sheaths of the wings and legs extending almost to the tip of the abdomen, and of a honey yellow color."

L. lysimachiæella (n. sp.)

The larva is cylindrical and very small. It makes a very small tentiform mine on the under side of the leaves of (*Lysimachia lanceolata*) the loosestrife. The imago is, no doubt, very small—probably not larger than *L. desmodiella*, Clem., which is the smallest known species of this genus; but I have not succeeded in rearing it.

L. ambrosiæella.—*Can. Ent.*, vol. iii., p. 127.

It is necessary to make some corrections of the specific description of this species, as follows, viz.: The basal streak is sometimes confined to the wing, and does not pass back out on to the tegular and thorax; neither are the face and under surface deep steel blue, as stated; this error must have been caused by some peculiar direction or character of the light by which it was viewed; they are rather of a shining metallic white, and there is a saffron yellow spot on each side of each abdominal segment; the legs are of the same metallic hue with the abdomen, but the tarsi are annulate with black; the anterior tibiæ are fuscous on their anterior surfaces, and the posterior are saffron yellow.

I have bred the species mentioned *loc. cit.* as mining leaves of *Helianthus gigantea* since the former note was written, and find it to be this species, as I supposed. It is very different from the species described *post* as *L. helianthivorella*, especially as to the character of the mine.

L. helianthivorella (n. sp.)

I do not deem it necessary to give a full description of this species, but will simply point out the particulars in which it differs from *L. ambrosiæella* (*sup.*): First—the mine of *ambrosiæella* is very small, and is not visible on the upper surface until the upper cuticle begins to die, when the larva is fully grown. The mine of *L. helianthivorella* is more than twice as large as that of *ambrosiaeella*, and is most distinct on the upper surface, when it produces a tubercular swelling.

Second—the larva of *ambrosiaeella* has the head obscurely streaked and clouded with fuscous. I have never found these markings on the head of the larva of *helianthivorella*.

Third—the imago of *helianthivorella* has a small white spot on the dorsal margin of the primaries, which is wanting in *ambrosiaeella*. The costal and dorsal streaks, which in *ambrosiaeella* are simply white, have a brilliant metallic gloss in *helianthivorella*, and the latter species is the largest, having an *alar ex.* one twentieth of an inch greater than *ambrosiaeella*. This appears to be a small difference, but when all other parts of the body are developed in the same proportion, it makes a very considerable; and when the insects are placed side by side, it makes a very striking difference in the size and appearance of the insects. I have compared numerous specimens of the two species, and notwithstanding their close resemblance, I have no doubt that they should be considered distinct species.

L. argentinotella, Clem.

In a single instance I have found this species mining the *upper* surface of elm leaves. Neither the mine, nor larva, nor insect, differed from those of the under surface of the same leaf. Prof. Frey, of Zurich, has strangely confounded it with *L. ulmella*, Cham.

L. alba-notella (n. sp.)

Head, palpi and antennæ glistening snow white; extreme apex of the antennæ dark brown; thorax white; primaries brilliant golden, rather pale, with a short, median, white basal streak, faintly dark margined toward the costa; basal fourth of the costa white (the base of the wings is also white, I think, but is a little rubbed, so that I can not be certain); four rather large, snow white costal streaks, the first of which is just before the middle of the costa, and the fourth is near the apex; three snow white, rather large dorsal streaks, the first of which is a little before the first costal streak, and the second and third of which are respectively opposite the second and third costal streaks, with which they sometimes meet, so as to form fasciæ. First costal and first dorsal somewhat oblique. First three costal and the three dorsal streaks all faintly dark margined before, the dark margin of the first costal being the most distinct; wings not dusted, but with an exceedingly minute and indistinct apical spot. *Al. ex.*, one fourth inch.

The larva is cylindrical, and makes a small tentiform mine on the under surface of the black jack (*Quercus nigra*). This species approaches most nearly to *L. argentinotella*, Clem. It is one of the willow oak miners mentioned in the *Canadian Entomologist*, vol. v., p. 166.

L. quercibella (n. sp.)

Glistening snowy white; extreme tips of the antennæ brown. A pale golden basal streak begins on the costa, at the base, and passes back parallel with the fold to the golden apical portion of the wing, and is interiorly very faintly dark margined; apical third of the fore wing pale golden, with a black apical spot, and dark brown hinder marginal line at the *base of the dorsal and apical ciliæ.* In the pale golden portion of the wing are *three* silvery costal and one silvery dorsal streak, all dark margined before. The first costal streak is larger than the others and its dark margin is somewhat oblique; the dark margins of the other streaks are straight; the dorsal streak is opposite to the first costal. Extreme costal ciliæ tipped with fuscous. *Al. ex.*, one fourth inch.

The larva is cylindrical, and mines the under surface of the leaves of black jack (*Quercus nigra*), and the mine is usually near to the edge. It is one of the mines mentioned as mining willow oaks. *Can. Ent.*, vol. iii., p. 166.

This species is between *L. Clemensella* and *L. lucidicostella*, having the basal streak as in the latter, but having a less portion of the wing golden, and a larger portion white, as in *Clemensella*.

L. fuscocostella (n. sp.)

Glistening snowy white; antennæ pale yellowish; primaries snowy white, with the apical half pale golden, with a pale golden basal streak extending from the base of the costa along the costal margin to the golden apical half of the wing, and internally very faintly dark margined; in the golden apical part of the wing are *four* short and (except the first) straight costal streaks, all faintly dark margined before, the dark margin of the first being more distinct than those of the others, and also being oblique and produced along the extreme costa to the base. The streaks are nearly equi-distant. There are two short and nearly straight white dorsal streaks, respectively, opposite the second and third costal streaks, both dark margined before; the dark margin of the second being at its apex, confluent with the dark brown hinder marginal line, which extends along the base of the dorsal and apical ciliæ. Extreme costal ciliæ tipped with dark brown, ciliæ white, apical spot black. Secondaries pale yellowish white, ciliæ white. Both pairs fuliginous beneath. *Al. ex.*, one fourth inch, Kentucky.

The larva is cylindrical, and makes a small tentiform mine on the under surface of leaves of white oaks (*Q. alba and Q. bicolor*). The mine is at the edge of the leaf, and the leaf is folded down over it.

This species resembles the preceding one very closely, and I would place it between that species and *L. lucidicostella.*

L. unifasciella (n. sp.)

Face, palpi, and under surface of the antennæ, silvery white. Upper surface of the antennæ dark brown, tuft silvery white, mixed above with pale golden, which becomes deeper at the sides; thorax and anterior wings rich reddish orange; there is a silvery white, slightly oblique fascia just behind the middle of the wing, nearest the base, on the dorsal margin, and curving slightly toward the base, near the costal margin, with small dark brown spot on the costa, margining it before, and distinctly dark margined behind, the dark margin being produced, both as a streak along the costa and a parallel one along the middle of the wing, the streaks spreading and uniting about the beginning of the costal ciliæ, thus inclosing an oblong patch, which is not dusted; the fascia is but little angulated, and does not have the appearance of two confluent streaks; apical margin, along the base of the dorsal ciliæ, very densely dusted with brown—the dusting in some specimens being connected with the dusted streaks above mentioned. A dark brown wider margined line at the base of the dorsal and apical ciliæ. Ciliæ yellowish. *Al. ex.*, one fourth inch, Kentucky.

The larva belongs to the second or flat group, and mines the upper surface of leaves of the black oak (*Q. tinctoria*). The maculæ and transparent spots are distinct. Head whitish. First and second maculæ dark brown, the others pale yellowish or pale brown. Frass scattered, mine oval at first flat, but afterward corrugated along the middle. It belongs to the same group as *L. bethunella*, which also mines the upper surface of leaves of *Q. tinctoria*; and it resembles *bethunella* closely as to the fascia, dusting and general color, but it lacks the costal and dorsal streaks of that species, and the fascia of *bethunella* is formed by the confluence of the costal and dorsal streaks, and is angulated. I have met with a specimen (*bred*) which I believe to belong to this species, but in which the dusting was almost entirely absent, possibly it may be a distinct species.

L. œriferella, Clem.

I have bred this species from the leaves of the black jack (*Quercus nigra*), and have found it so often in groves of white oak (*Q. alba*) and black oak (*Q. tinctoria*), where there were no black jacks near, that I think it must mine the leaves of those species also.

L. Castaneœella (n. sp.)

Face and palpi silvery white; tuft, thorax and anterior wings reddish golden (or pale reddish orange?); antennæ dark brown, with a faint, narrow, whitish annulation at the base of each joint, toward the apex; each alternate joint is white, as is also the case in *L. bethunella* and *L. unifasciella*. There is a small white spot on the costal margin of the anterior wings, about the basal fourth, and therein it differs from *unifasciella* and a silvery fascia just beyond the middle (as in *unifasciella*, but not dark margined on the costa before, as in that species). The wing behind the fascia is dusted along the middle, the dusting extending over the entire apex. A small, white costal streak at the beginning of the costal ciliae, and another small one just before the apex, both in the dusted portion as in *bethunella*. A dark brown hinder marginal line, formed by the dusting, at the base of the ciliæ. *Al. ex.*, one fourth inch, Kentucky.

The larva is flat, and mines the upper surface of leaves of the chestnut, (*Castanea Americana*), and of a species of oak. (The leaf was too much injured to determine the species of oak). When it was gathered from oak, the mine was supposed to be that of *L. hamadryadella*, and the larva was not closely observed, and it was placed in a large breeding cage with several other well known species, for the purpose of getting duplicates. Subsequently, on looking over them, I was surprised to find that this was an unknown ribbon like mine: not corrugated along the center, and with the pupa lying naked on a few threads of silk. It was then separated from the other mines, and produced this species. The imago is between *bethunella* and *unifasciella*, having some, but not all of the streaks of *bethunella*, which are wanting in *unifasciella*. The fascia resembles that of *unifasciella* more than that of *bethunella*. The characters of the oak leaf mine were caused, I think, by confinement in the breeding cage; those from the chestnut resembled those of *L. bethunella.*

Lyonetia—*L. apicistrigella* (n. sp.)

Snowy white; antennæ faintly tinged with fuscous; before the middle of the dorsal margin of the primaries is a blackish, or, in some lights, golden brown streak, pointing obliquely backward; just behind the middle is a larger one, and behind this again is a patch or streak of the the same hue extending along the dorsal margin to the beginning of the cilia. Behind the disc, and continuous with the second dorsal streak, is a narrow, linear, median streak, of the same hue, which extends through the middle of the apical part of the wing, to a small golden brown patch, where it is deflected to the dorsal margin, passing around the golden brown patch, and along the dorsal margin, at the base of the cilia, to and around behind the circular, shining, apical spot, which is behind the golden brown patch; in its course it touches the blackish margined patch before the cilia; and the portion of it which extends along the base of the cilia contains two minute white dorsal streaks, the last of which is very small and very close to the apical spot. On the costal margin, about or a little behind the middle, is a rather indistinct blackish streak, which is continued just within and parallel to the margin for a short distance toward the base; behind it is another larger and more distinct streak, and behind this is another still larger and more distinct, all of the same hue, and pointing obliquely backward and behind them at the base of the cilia are three other small and indistinct ones of the same hue, pointing obliquely forward, the last being very close to the apical spot. *Al. ex.*, one third inch. Captured at the light in Kentucky, in August.

Another specimen, taken about the same time, I was inclined to regard as distinct, but, remembering the fate of two or three supposed European species, which prove to be only varieties of *L. clerckella*, I am inclined to regard this as not specifically different from the species above described. I have not seen *L. speculella*, Clem., but evidently this can not be it, as Dr. Clemens does not mention the fuscous line which passes through the apical part of the wing, and the costal markings appear to differ. However, considering the range of variation in *clerckella*, in Europe, it is possible that both *speculella* and the species above described may be mere varieties of it.

OPOSTEGA. *O. (?) quadristrigella* (n. sp.)

Silvery white; under surface of body, legs and antennæ sordid yellowish. There is a pale fuscous spot on the dorsal margin of the primaries, before the middle, and the extreme apical part of the primaries is very pale golden yellow, with a black spot at the apex. There are in the yellowish apical part two black costal streaks, and one dorsal one, and one transverse streak in the cilia behind the spot; the first costal streak is very oblique, placed before the apical spot, pointing toward but not quite reaching it; the second is perpendicular to the spot; the dorsal streak is oblique and opposite to the first costal one, and both of these are margined narrowly behind with silvery white. *Al. ex.*, three eighths inch.

A single specimen came to the light at Camp Bee Spring, of the Kentucky geological survey, in Edmondson county, in the early part of July. The eye caps in this species present a singular structure, the scales being arranged in a series of alternate concentric rows; the tip of the primaries are turned up, or rather bent outward.

PHYLLOCNISTIS. *P. populiella* (n. sp.)

Glistening snow white; apical third of the primaries suffused with golden yellow. There are five, short, blackish costal streaks, the first very oblique at the beginning of the ciliæ, the others in the ciliæ; the fifth is opposite the apical spot, and a little behind it. From the apical spot two black streaks diverge through the apical ciliæ. Three dorsal blackish streaks, the first being very oblique, and placed opposite the second and third costal streaks; the second is very oblique, opposite the third and fourth costal streaks, and points toward and almost attains the apical spot; the third dorsal is opposite to and almost continuous with the fifth costal streak. The third and fourth costal streaks are a little nearer together than the others. Under side of all the wings suffused with fuscous. *Al. ex.*, one fourth inch, Kentucky.

The larva mines the upper surface of the leaves of poplars (*P. dilatata* and *P. monilifera*). The mine is very winding, white, with a central, indistinct line of frass. It resembles that of *P. liriodendronella*. *P. suffusella* mines the leaves of poplars in Europe, but it seems to be quite different from this species.

P. liquidambarisella (n. sp.)

I am unable to distinguish this species from *P. vitifoliella*, Cham., by any characters of the imago, or, indeed, in any way except by the mine.

The mines of both species are long and tortuous, but that of *vitifoliella* is distinct, and with a well marked central line of frass, whilst that of *liquidambarisella*, like that of *P. vitigenella*, is indistinct, without any central line of frass, and resembling the indistinct track of a small snail. It mines the upper surface of the leaves of the sweet gum, *Liquidambar styraciflua*, in Southern Kentucky throughout the summer.

P. ampelopsiella (Can. Ent., vol. iii.)

I have repeatedly bred this species from the mines imperfectly described *loc. cit.* p. 207. This mine is quite distinct from any other *Phyllocnistis* mine, in that whilst it is a narrow line like that of the other species, and whilst it is white, like those of *P. vitifoliella* and *P. populiella*, yet the narrower line of which it is composed winds about over the same limited space, to such an extent that the mine looks like a large white blotch on the under surface of the leaves of *Ampelopsis quinquefolia*. Yet, strange to say, I have almost as often bred from the same sort of mines, in the same sort of leaves, gathered at the same time, and from the same vine, a form which lacks the characteristics of *ampelopsiella*, and is undistinguishable from *P. vitifoliella*, which makes an entirely different mine in grape leaves. *P. vitigenella*, Clem., from another quite different mine in grape leaves, is in the imago intermediate between *P. vitifoliella* and the form of *ampelopsiella*, described *loc. cit.* That is, there is a mine in grape leaves quite distinct from any other, and which produces only *P. vitifoliella*; there is another distinct mine in grape leaves, which produces only *P. vitigenella*; there is a mine in the leaves of *liquidambar* identical with that of *P. vitigenella* in grape leaves, but which produces an imago undistinguishable from *P. vitifoliella*; and, again, there is a mine in the leaves of *ampelopsis* very distinct from all of those above mentioned, yet which produces two forms of the imago, one of which resembles *P. vitigenella*, but is, nevertheless, distinct from it, and the other of which is undistinguishable from *P. vitifoliella*, from grape leaves. Were not the differences in the mines so great, one would be strongly inclined to believe that all of these species were varying forms of one species. But, on that hypothesis, it would be difficult to account for the differences between the imagos and mines of *vitifoliella* and *vitigenella* from grape leaves. *Vitifoliella* and *vitigenella* mine the upper and *ampelopsiella* only the lower surface of the leaves.

P. smilacisella (n. sp.)

I know this species only in the larval state, and it appears to be very rare. I have only twice met with it; on both occasions in Southern Kentucky, in July, and in each case the larva was just dead in the mine, and the parasitic larva which had killed it was lying beside it. It mines the upper surface of *Smilax glabra* leaves. I have never found it in Northern Kentucky, though *Smilax* is abundant. The mine is of a snowy white, with a central line of frass, long and winding, and resembles that of *P. liriodendronella*, Clem., in the leaves of the tulip tree (*Liriodendron tulipfera*); *liriodendronella*, however, mines both surfaces of the leaves, not, as Dr. Clemens states, the under surface only. I have not succeeded in breeding the species, which I believe to be *P. liriodendronella*, from leaves of magnolias. At p. 207, vol. iii., in the *Canadian Entomologist*, I have stated that the species of magnolia so mined were *M. glauca* and *M. grandiflorea*. It may mine those species, but the leaves in which I have taken it were those of the cucumber tree, *M. acuminata*, and the umbrella tree, *M. umbrella*. The mines in poplar, magnolia, liriodendron and smilax leaves are similar to each other, white, with a line of frass, and the second and third, and possibly the first and fourth, are found on both sides of the leaves, long and winding; at some part winding in concentric circles. The mines of *vitigenella* and *liquidambarisella* resemble each other: they are like small snail tracks, indistinct, long and irregular, and confined to the upper surface, and show no line of frass. The mine of *Ampelopsiella* is always on the lower surface, and by confluence of its narrow lines becomes a white blotch.

The mines of *vitifoliella*, and the mine of the unknown species mentioned in the *Canadian Entomologist*, vol. iii., p. 208, are long, winding, irregular, distinct, with a central line of frass, and confined to the upper surface.

TISCHERIA.—*T. tinctoriella* (n. sp.)

Palpi and face saffron yellow: vertex, thorax and anterior wings rather deep saffron yellow, dusted with dark brown; the dusting is rather dense along the margins of the wings and in the apex, and there is a patch of brown scales on the dorsal margin, at the beginning of the ciliæ. *Al. ex.*, over one fourth of an inch, Kentucky.

The larva mines the leaves of the black oak (*Quercus tinctoria*) and the chestnut (*Castanea americana*). The mine is very singular, and is one of the prettiest mines that I have seen. Before I had seen the larva, I supposed it to be the mine of a *Lithocolletis*. At first a small portion of the upper cuticle of the leaf, nearly circular in outline, is loosened; then the larvæ proceeds to construct a circular *nidus* or depression, lined with silk, and precisely like that of many species of *Lithocolletis* of the flat group; at one side of this *nidus* is the little circular aperture from which the frass is ejected, and from which the imago ultimately makes its egress; then the mine is spread out from the *nidus*, in every direction, except on the side of the aperture. It is white, streaked with short, zigzag, purple lines, which are especially abundant on the *nidus*. When alarmed, the larva retreats into its *nidus*, and in it it also passes the pupa state. It is altogether unlike any other mine that I have seen.

T. badiiella (n. sp.)

Very pale lemon (almost creamy) yellow, becoming slightly reddish along the apical half of the costal margin and around the apex. Palpi and antennæ of the general hue. A small spot of scattered brown scales at the beginning of the dorsal cilia; a row of scattered brown scales around the apex, at the base of the ciliæ, and a similar row along the basal half of the dorsal margin. *Al. ex.*, one fourth inch, Kentucky.

The larva mines the upper surface of leaves of the white oak (*Quercus alba*). The mine, while fresh, is white; when dry, it becomes slightly yellowish. It resembles the mine of *T. malifoliella*, being oblong and of irregular outline, and when mature the upper cuticle becomes corrugated. It is usually placed near the edge of the leaf, sometimes at the edge, in which case, when it is mature, the edge of the leaf is folded upward, over it. Possibly this may be *T. zelleriella*, Clem., but it is almost impossible to recognize any of these closely resembling species in Dr. Clemens' brief description. I have another species (?), at least an insect more deeply colored, bred from mines in leaves of *Q. obtusilobia*, which I suppose to be *zelleri l'a.* Both mines resemble that described by Clemens as that of *zelleriella*, and they may both prove to be lighter or darker shades of that species.

T. quercivorella (n. sp.)

Face, palpi and antennæ very pale yellowish; vertex darker yellow: thorax and primaries pale lemon yellow, the primaries becoming tinged with red at the apex, where they are sparsely dusted with pale brownish red; ciliæ of the general hue. Hind wings and ciliæ pale yellow or fulvous. The most striking colorational peculiarity abou it is the large fuscous patch on the under side of the wings (both pairs at the base. *Al. ex.*, nearly one third inch, Kentucky.

The larva mines the upper surface of the leaves of *Quercus nigra* and *Quercus obtusiloba*. The mine is at the edge of the leaf, which is curled upward, over it.

Possibly this may be *T. citripenella*, Clem., but I can not at all reconcile his description of that species with the markings of this. His account of the mine agrees better with this, but he does not say what species of oak he found it on, nor does he mention the conspicuous brown spot on the under surface of the fore wings, though he mentions something like it on the hinder pair.

T. fuscomarginella (n. sp.)

Golden yellow; the fore wings more reddish, and becoming deeper toward the apex, where the margins, especially the costal margin, is deeply suffused with purplish fuscous, which in some lights is distinctly purple. Ciliæ reddish yellow, tinged with fuscous along the costa. *Al. ex.*, one fourth inch, Kentucky. The fuscous margins of the fore wing and the character of its mine distinguish it from other known species.

The larva mines the leaves of white oaks (*Quercus alba*) on the *under* surface, at the edge, the leaf being curled *downward*, around the mine.

T. zelleriella (?)—Clem.

Dr. Clemens does not say what species of oak is the food plant of this species, and his description is not definite enough for a species of a group, the species of which resemble each other as closely as do our oak-feeding *Tischeriæ;* I am therefore not certain that my specimens belong to this species. My supposed *zelleriella* were bred from mines on the upper surface of *Quercus obtusiloba*.

T. purinosella (n. sp.)

White, almost hoary, with a faint tinge of creamy yellow; antennæ yellowish; vertex dusted with fuscous; thorax and discal portion of the fore wing sparsely dusted with fuscous; basal half of the costal margin and apex of fore wings densely dusted with fuscous; ciliæ pale fulvous; anterior surfaces of first two pairs of legs dusted. *Al. ex.*, one fourth inch, Kentucky.

The larva mines the leaves of the white oak (*Quercus alba*).

T. Castaneæella (n. sp.)

Face and palpi whitish yellow; vertex yellowish white. Thorax and primaries pale saffron, almost golden yellow, without markings, but becoming darker and more reddish toward the apex of the wings, where they are dusted sparsely with brownish red or rather with dark brick red. Ciliæ of the general hue; abdomen beneath densely dusted with brownish yellow.

This is the largest *Tischeria* that I have met with, measuring nearly one third inch in *al. ex.* The larva mines the leaves of the chestnut (*Castanea americana*).

The oak-feeding *Tischeria* of this country form a very difficult group. The three species described by Dr. Clemens are stated to have been bred from oak leaves, but Dr. Clemens does not say what kind of oak leaves. *T. badiiella*, Cham., and *T. quercivorella*, Cham., were bred from *Quercus alba*, *Q. nigra*, and *Q. obtusiloba.* They are the only species known to me which might be mistaken for either of Dr. Clemens' three oak-feeding species; for, while considering Dr. Clemens' description of the imago alone, *T. tinctoriella*, Cham., might possibly be mistaken for one of them, the character of the mine separates it distinctly from them all, and *T. fuscomarginella*, Cham., is widely enough separated by the brownish margins of the primaries, and by the character of the mine, the edge of the leaf being curled downward, although it is found in the leaves of *Q. alba.* *T. tinctoriella* mines leaves of *Q. tinctoria.* In a publication by Prof. Frey, of Zurich, and M. J. Boll, of Baumgarten, two species are mentioned which were bred from leaves of *Q. tinctoria*, gathered by Mr. Boll in this country, and which Messrs. Boll and Frey suppose to be *T. zelleriella*, Clem., and *T. quercitella*, Clem. But *T. tinctoriella* is the only species that I have ever bred from *Q. tinctoria*, and the mine separates it very distinctly from the other species; it does not curl the leaf at all, and is at first sight much more likely to be mistaken for the mine of a *Lithocolletis* larva of the flat group than for that of a *Tischeria.* *T. castaneæella* might possibly be mistaken for *zelleriella*, but for its large size.

T. malifoliella, Clem.

In vol. iii., p. 208, of the *Canadian Entomologist*, I have recorded the breeding of this species from the leaves of various plants, and suggested that it probably mined other *Rosaceæ*; since then I have also bred it from the dewberry (*Rubus canadensis*).

In the pamphlet above mentioned, Prof. Frey and Mr. Boll mentions having bred a species from leaves of the blackberry (*Rubus villorus*), which they consider distinct from *malifoliella*, and described under the name of *T. ænea*. They also state that they have bred an allied species, which they describe as *T. rosticolla*. The species from the blackberry I have known for several years; I have not considered it distinct from *malifoliella*, Clem., and I regard the specimens bred from all the species of *Rubus*, *Pyrus*, *Malus* and *Cratægus*, as belonging to the same species, *T. malifoliella*, Clem. *T. rosticolla* I have not seen; I incline to doubt its specific difference from *malifoliella*.

In the two following allied species I observe a peculiarity which I have not heretofore observed in any other species, nor have I seen any reference to it by any author. It is this: the third joint of the palpi have two long bristle-like scales, about as long as the joint itself, which spring from its base on the under side, and which I think are usually appressed to the surface, so as not to be distinguished from it, but which it can, and *in articulo mortis* always does, separate from the joint, so as to form with it a letter V.

T. ambrosiæella (n. sp.)

Lemon yellow, or, perhaps, more properly, ocherous yellow. Face and palpi whitish yellow; thorax and fore wings dusted with dark brown, the dusting being almost uniform over the general surface of the wing, but in some portions aggregated into lines and spots. One of these lines begins on the costa, not far from the base, and passes very obliquely backward as far as the fold in the direction of a small patch of dusting about the middle of the dorsal margin. There is a larger patch of dense dusting immediately before the costal cilia, and an opposite dorsal one, and the apex is densely dusted. The cilia are of the general hue, or a little paler, with a dark brown "hinder marginal" line at their base. The antennæ are brown, and the first two pair of legs are dark brown on their anterior surfaces; the posterior pair and the venter are yellow. *Al. ex.*, a little more than one fourth inch, Kentucky; in Summer and Fall.

The larva mines the leaves of *Ambrosia trifida*. The mine is irregular in outline, longer than wide, and sordid whitish; the parenchyma being eaten out entirely, except within the limits of the circular *nidus*, in which the pupa reposes, and into which the larva frequently retreats. The nidus bears some resemblance to those of the beetle *Metonius laevigatus* and those of some species of *Lithocolletis* of the flat group, as *e. g.*, *L. guttifinitella*, Clem., but it differs from mines of that character by being most distinct on the *under*, instead of the upper side. It is indicated on the upper side only by a slight mamillary bulge, the parenchyma not being removed, while on the under side the cuticle is loosened and the parenchyma eaten over the whole mine. The imago emerges through the under surface. In all these respects it is in marked contrast with the species described below, and which is nearly allied to it in many respects.

I have also received from Miss Mary E. Murtfeldt, of St. Louis—to whom I am under many obligations for "Micros"—specimens which I believe to belong to this species, and which only differ from it by being a little paler and less dusted. Miss Murtfeldt bred them from mines in the leaves of *Ambrosia artemisifolia*, one of which she sent to me. This mine is at the edge of the leaf, while in *A. trifida* the mine occurs anywhere on the leaf; and the species from *artemisifolia* emerges *through the edge* of the leaf, instead of from the under surface, nevertheless, I think it is the same species.

T. heliopsisella (n. sp.)

This species, while closely allied to the preceding, differs from it strikingly in some respects. It also mines the leaves of *A. trifida*, and also those of *Heliopsis lævis*. The mine is of irregular outline, approaching the circular or ovate form, and larger than that of *ambrosiæella*. It is placed anywhere in the leaf; the parenchyma is entirely eaten out, except from the *under* surface of the *nidus*, which is most distinct on the *upper* surface. The imago emerges from the *upper* surface. The mine is sordid whitish, and the *nidus* is indicated on the *under* surface by a mamillary bulge. The insect, though similarly colored, is decidedly distinct from *ambrosiæella*, besides being larger, measuring three eighths inch in *al. ex.* In Kentucky it is found at the same seasons with *ambrosiæella*, which it resembles, but is more distinctly marked, and more densely dusted.

The two anterior pairs of legs are dark brown on their anterior surfaces; the third pair is yellow, *with the tibia marked with brown on the outer surface, and the tarsi dark brown annulate at the joints, with yellow;* the venter is deeper yellow, *and tinged with fuscous at the margins of the segments*; the palpi and head are ocherous yellow, and the tuft on the vertex is a little flecked with brown. The thorax and anterior wings are deep ocher yellow, with golden reflections in some lights; the thorax is dusted with dark brown scales, *with a dark brown line from the anterior margin to the tip, and another over the tegulæ, passing back along the base of the dorsal margin of the fore wings;* the fore wings are less dusted, but are traversed by *numerous dark brown oblique streaks, which are confluent, and which occupy nearly half the superficies of the wing,* which is of a deeper ocherous yellow than in *ambrosiaella;* as in that species, the entire costal margin is dusted with dark brown, the dusting, however, in this species *is very dense,* and is continuous with the dusting of the apex; as in *ambrosiaella,* also, there is a dark brown streak (which in *ambrosiaella* is only a streak of dusting), which begins on the costa, not far from the base, and passes very obliquely back as far as the fold, in the direction of a dark brown spot, placed about the middle of the dorsal margin. But in *heliopsisella this streak is intersected about its middle by a straight, median, dark brown streak from the base of the wing, and the oblique streak itself sends off backward, within the costal margin, a short dark brown streak which runs parallel to the costa, and which is connected across the wing, just behind the middle (by a streak of dusting), with a dark brown streak, which is emitted obliquely backward from the dark brown dorsal spot. About the apical third of the wing length a narrow dark brown streak passes obliquely across the wing to the dorsal margin, at the beginning of the cilia, and proceeds thence around the base of the dorsal cilia.* This oblique line, moreover, from about its middle, *sends obliquely backward two lines to the apical cilia,* which are a little lighter than the ground color of the wing. The dark brown lines which thus traverse the surface of the wing and intersect each other are somewhat difficult to trace out, because they occupy so much of the surface of the wing, and the spaces of the ground color are also a little dusted with brown. The ground color is deeper than in *Ambrosiaella,* and the dark brown scales are condensed into more distinct lines. It has all the marks of that species more developed, and others, which are indicated by the italics above.

Œcophora—*Œ. Shaleriella* (n. sp.)

This insect was captured frequently at Camp Bee Spring, of the Kentucky Geological Survey. I place it in this genus, which it seems to me to approach nearly, though it is not a typical specimen of the genus. The species of this group (which I incline to think ought not to be included in the family *Gelechidæ,* though they approach it closely), are sometimes difficult to locate among the various genera composing it. Thus, *Callima argenticinctella,* Clem., appears to me to be very nearly, if not quite, a typical *Œcophora; Œ. boreasella,* Clem., differs slightly from it, but not enough to remove it from the genus; *Œ. australisella,* Cham., and this species have strong affinities with *Dasycera* and *Œcogonia* and

Endrosis, and *Hamadryas bassettella*, Clem., approaches *Butalis* somewhat, though it is perhaps nearer to *Dasycera*, and will probably be found to belong to *Pancalia*.

In this species the antennæ are more like those of *Œcogonia*, though smaller even than in that genus; the palpi more slender than in *Callima argenticincella*, or *Œcophora boreasella*, resemble those of *Œcogonia* perhaps more than those of *Dasycera*; the ornamentation is rather that of an *Œcophora*; the form of the head allies it to *Dasycera*, being a little full in the face, and not rising high above the eyes. The form and neuration of the wings is that of *Œcophora australisella*, having, however, in the fore wings, the apical branch of the subcostal vein simple instead of furcate, as in the latter species, and in the true *Œcophora*, and it agrees with *Œ. australisella*, and differs from the true *Œcophora* in its slender palpi and antennæ. *Œ. australisella* has the basal joint of the antennæ clothed with long scales on its front margin, depending over the eyes, as in *Endrosis*, and this species *Œ. shaleriella*, unlike all the others, has the stalk of the antennæ ciliated. The neuration of this species is exactly that of *Œ. boreasella*, which see.

Second joint of the palpi white, with a pale yellowish tinge toward the apex; third joint black; antennæ dark brown, with silvery cilia; face white; vertex dark brown; thorax and base of the primaries brown, with a faint metallic luster, and this hue extends all along the costal and dorsal margins of the fore wings, to a fascia, which is placed at about the basal fifth of the wing, and is margined both before and behind with the metallic brown hue, being entirely surrounded by it: in the brown basal portion of the wing, before the fascia, is a lemon yellow spot; the fascia is silvery white, with a pink tinge above the fold, and simply white beneath it; behind the fascia the wing is lemon yellow on the disc, but the brown hue still extends along both the costal and dorsal margins, and about the middle of the costal margin the brown color spreads, so as to cover the costal half of the wing beyond the middle; it also deepens in color, and extends as far as the cilia, and contains near the middle of the wing (just behind the point where it widens) a patch of scattered silvery scales. It is followed on the costal margin by a lemon yellow spot, which is margined before (next to the brown) by a silvery fascia. Beyond this lemon yellow spot the apical part of the wing is brown, and so are the dorsal cilia, except a small lemon yellow spot at their beginning, and also immediately at the apex, where they are lemon yellow. Beyond the first fascia the brown of the dorsal margin does not extend to the cilia, but passes gradually into a large velvety black patch on the margin, which contains three bright metallic spots, and two small lemon yellow ones, and which is separated from the brown of the costal half wing by the lemon yellow of the disc, which extends backward to the middle of the dorsal cilia. Secondaries fuscous. *Al. ex.*, one half inch.

Coleophora—*C. Shaleriella* (n. sp.)

White; extreme costa near the base brown. The fore wings are marked with several longitudinal ocherous lines, which appear in some lights to be faintly tinged with golden. One of these lines begins on the base just within the costa, and reaches the costal margin just before the cilia; another begins at the base beneath the fold, and reaches the dorsal margin at the fold; another extends along the dorsal margin; there is an indistinct line above the fold, but close to it, which begins about the basal one fifth and extends parallel to the fold to the dorsal margin; two others begin at nearly the same point with that last mentioned, one of which goes to the costal cilia, and the other along the middle of the wing, sending off one (or two?) branches to the costal cilia. The cilia are yellowish white. The antennæ are simple, and are not annulate with brown. *Al. ex.*, 7-16ths inch.

This species evidently approaches *C. cratipenella*, Clem., which I have not seen; but the markings on the wings differ from Dr. Clemens' description, and *cratipenella* has the antennæ annulate with brown. It is sufficiently distinguished from *C. gigantella*, Cham., by the size as well as by the ornamentation. It was taken at the light at Camp Bee Spring, of the Kentucky Geological Survey (Edmonson county), and I have named it in honor of Prof. Shaler, State Geologist of Kentucky.

Ornix—*O. quercifoliella* (n. sp.)

Iron gray, mottled with dark brown; labial palpi gray, with two brown annulations between the middle and tip of the third joint. Legs and under surface pale yellowish gray, streaked and spotted with dark brown; antennæ dark or brownish gray, faintly annulate with pale gray; thorax brown, with the tip pale gray; fore wings iron gray, obscurely streaked and spotted with dark brown and white, having a brown spot about the middle of the costal margin, behind which is a curved brown streak, which passes obliquely backward, nearly half way to the dorsal margin, and thence curves backward toward the tip, becoming almost confluent with another straight, oblique costal streak, behind which again is another very narrow, straight, oblique, costal, dark brown streak; behind the brown spot above mentioned are two or three very indistinct pale gray streaks; the curved streak is margined behind indistinctly by pale gray, and on the costa, between the curved streak and the first straight, oblique streak, is a minute white streak, margined all around by a narrow, dark brown line; the first straight, oblique streak is margined behind faintly by pale gray, and the third (narrow) oblique streak is margined behind by a narrow, faint, metallic white streak, which passes obliquely backward to the middle of the apical part of the wing. At the apex is a circular brown spot, which has a small white costal streak or spot before it, and also an opposite dorsal one, and is margined behind by an almost semi-circular, narrow, white line, along the base of the cilia, which are dark brown at the apex; the dorsal cilia are pale gray. The apical spot is thus, by means of the semicular line and the opposite costal and dorsal streaks, entirely surrounded by white, except in front, and partly on the costal margin. The dorsal margin of the wing is largely margined with white, especially near the base; just within the basal fourth is a very small, dorsal, white streak; another, a little larger, is placed just before the middle; just behind the middle are some indistinct, zigzag, brown lines, partly margined with white; about the apical fourth is a very oblique, slightly curved, dorsal, white streak, dark margined behind, and extending around and beyond a small dark brown dot, just before the cilia. *Al. ex.*, one third inch.

A single specimen received from Miss Murtfeldt, who informs me that the larva curls down the edge of oak leaves. In its earlier stages it is, probably, a leaf miner.

NEPTICULA.—*N. castaneæfoliella* (n. sp.)

This species makes a linear, crooked mine on the upper surface of leaves of the chestnut (*Castanea americana*). The larva is bright green, and the mine has a distinct central line of frass.

The imago has the palpi, vertex and eye-caps creamy white; head dark brown; thorax and primaries dark purple brown, with pale ciliæ. Posterior tibiæ and anterior legs, except the femora, dark brown; legs otherwise sordid whitish, silvery tinged; abdomen greenish above, beneath whitish, margined with fuscous along the sides; antennæ brown above, pale fuscous beneath, and very faintly annulate with white. *Al. ex.*, $\frac{5}{32}$ inch, Kentucky.

N. fuscotibiella, Clem. *N. ciliæfuscella*, Cham.—*Can. Ent.*, vol. iv., p. 128.

Dr. Clemens describes the species as having the ciliæ pale grayish. In the captured specimen, from which *ciliæ fuscella* was described, the ciliæ appeared black, probably from having been a little singed by the lamp; since then I have bred the species from willow leaves, and I am satisfied that it is the same described by Dr. Clemens. The mine is long, narrow, and on the upper surface it gradually widens throughout its entire length, but does not become wide at any time, and at about the middle of its length it is bent sharply backward, the large end being bent back to the narrrow one, like a long, slender club, bent double. *N. apicialbella*, Cham., only differs by having the *apical* ciliæ white.

N. nigriverticella (n. sp.)

Face rust red; palpi silver-tinged, yellowish white; tuft, small and black; eye-caps pale ocherous; antennæ fuscous, silver-tinged. Thorax and primaries pale ocherous, faintly dusted with fuscous; at the base of the dorsal margin of the fore wings is a purple black spot, extending half across the wing, and just at the beginning of the cilia is a wide purple black fascia; cilia very pale ocherous. *Al. ex.*, one fifth inch, Kentucky. The food plant is unknown. It was taken May 12th, on the hunk of a wild cherry tree, sitting very close. But I know only one *Nepticula* mine of the wild cherry leaves, and the species which produces it is very different from this, and has been already described by me as *N. serotinæella*.—*Can. Ent.*, vol. v., p. 126.

N. resplendensella (n. sp.)

In rich, gorgeous and brilliant adornment this species surpasses all other *Nepticulæ* known to me; indeed, I had almost written that it surpasses any other microlepidopteron known to me, and, indeed, while some others surpass it in variety of coloration, I know of none more gorgeous and brilliant. The scales are very fine and smooth, and shining, unlike the rough, large scales of many species. The palpi are whitish; the tuft pale reddish saffron, and the tips of the tarsi are pale yellowish; in other respects it is exceedingly difficult to determine what its real hues are. To the naked eye it appears of a brilliant deep black, with a wavy golden band extending along the middle of the fore wings, from the base to the tip. Under the lens the basal half of the costal margin of the fore wings, and a large spot extending along the base of the costal fringe, nearly to the tip, and more than half across the wing, are deep purple or deep velvety black, with a rich purple tinge; all other parts of the wings, the fringes, the body, and legs, are of a brilliant metallic luster, like burnished steel or silver, with prismatic reflections, and, in a bright light, glistening like gold in the sunlight.

I think that if one could ever get rid of its prismatic resplendence, its true color would be best described as bright silver, tinged with gold, except the basal half of the costal margin, and the large spot at the base of the cilia, before mentioned, the true color of which are a rich purple black. *Al. ex.*, one fourth inch. Two specimens captured May 23d, under hackberry trees (*Celtis occidentalis*).

N. unifasciella (n. sp.)

Palpi, legs, under surface of the thorax and abdomen, upper surface of thorax and basal two thirds of the upper surface of the wings shining black, with a brilliant metallic luster, like polished steel or silver, so that a silvery white, rather wide, fascia, placed at the apical third of the wings, is scarcely distinguishable in some lights from the remainder of the wing; this fascia is nearly straight, and the wing behind it and the fringes are deep purple black, and the costal margin, from the base to the fascia, also shows the purple gloss. Under surface of the wings deep black; antennæ black; head and face rufous; eye-caps silvery white. The scales are fine and smooth, and it is no mean competitor of the preceding species as to beauty. *Al. ex.*, three sixteenths inch, Kentucky.

BUCCULATRIX—*B. ambrosiæfoliella* (n. sp.)

Face white; eye-caps white; antennæ with alternate annulations of white and dark brown; vertex white, stained with ocherous brown: thorax ocherous yellow, faintly sprinkled with brown. The ground color of the fore wings seems to be white, but it is so much overlaid with pale ocherous that the white is only distinct in a few places; thus, the basal portion along the costa, for nearly one third of the wing length, is whitish, faintly sprinkled with pale ocherous and brown; and there is a distinct, curved, white streak, forming an arc of a circle, beginning on the dorsal margin, just before the middle, and curving back to the dorsal margin, just behind the middle, and margined toward the dorsal margin of the wing (that is, within the arc) by black scales; the scales between this black internal edging of the arc and the costal margin are ocherous; the extreme costa, near the base, is dusted with dark brown, which ends just before the middle in a short, oblique, brown streak; there are also scattered blackish scales along the dorsal margin, near the base. About the middle of the costal margin begins a long, dark brown streak, which passes obliquely across the wing, to the hinder angle, and thence along the base of the cilia to the tip ; it is margined on the costa rather indistinctly by white. The dorsal cilia are whitish, mixed with ocherous; there is an oblique streak of dark brown in the cilia behind the tip, and a few scattered scales of the same hue, above the base of the costal cilia. Under surface and legs very pale ocherous. *Al. ex.*, 5-16ths inch. The larva feeds on the leaves of *Ambrosia trifida.*

B. quinquenotella (n. sp.)

Face, and entire under surface of body and legs, silvery white, with a faint, yellowish tinge, and the tarsi dusted with brown on their anterior surfaces; antennæ with alternate annulations of silvery white and black; tuft silvery white, becoming brick red on top; eye-caps silvery white; fore wings reddish orange or reddish ocherous, according to the light, and sparsely flecked with brown. The basal part of the fore wings is much lighter than the remainder, and the apical part is more distinctly yellowish than the middle, which is darker. There are three silvery white costal streaks: the first is placed at about the basal fourth, and extends obliquely across the wing to the dorsal margin, just before the dorsal tuft, but becomes near the dorsal margin somewhat suffused with or even interrupted by yellowish scales; the second is small, straight, near the middle of the wing, and the third is placed just behind the beginning of the cilia, is long and narrow, almost crossing the wing to the dorsal cilia, where there is a dorsal, silvery white spot immediately before it, at the beginning of the dorsal cilia. There is a patch of blackish scales in the apex margined before by a silvery streak, which does not reach either margin. The fringes are silver gray, with a very distinct, dark brown hinder marginal line at their base. The dorsal tuft is dark brown, and in perfectly fresh specimens there are a few scales longer and darker than the others projecting from it. *Al. ex.*, one fourth inch, Kentucky.

It seems to resemble Dr. Clemens, *B. trifasciella*, but can not be it if Dr. Clemens has correctly described that species.

B. packardella, Cham.—*Can. Ent.*, vol. iv., p. 151.

I have bred this species from cocoons found on the trunks of beech trees. The description *loc. cit.* was made from two specimens taken at the light, and on comparing them with bred specimens, I find that they were a little singed. In the bred specimens the "small brown dot on each side of the apex of the thorax" is absent, and the portions described as orange chrome vary with the light, becoming golden brown or greenish brown, according to the light; there is also an indistinct tuft of brown scales on the dorsal margin, about the middle. I have not seen *B. trifasciella*, Clem. It must resemble this species closely, but I do not find the third silvery streak mentioned by Dr. Clemens.

Class *Cephalopoda* (Cuvier), as represented in the Cincinnati Group.

By S. A. Miller.

This class is divided into two orders: 1st, *Dibranchiata* (two gilled); 2d, *Tetrabranchiata* (four gilled). The *Dibranchiata* are the highest organisms in the molluscan scale, and are extensively represented, by numerous families, in the seas, at the present time, but are not known to have existed during the Silurian age The *Tetrabranchiata* are represented by only one living family, the *Nautilidæ*, though they abounded in the ancient seas of every age, from the Silurian to the Tertiary, and twenty-five or thirty families are known only by their fossil remains. In these families more than 2,000 species have been described.

The *Nautilus pompilius*, it is said, inhabits a depth of from 20 to 30 fathoms, where it creeps, like a snail, on the bed of the sea. The chambers of the shell, not occupied by the animal, are said to contain water. The animal is attached to the shell, by means of two lateral adductor muscles, and by a continuous horny girdle around the mouth of the body chamber. The septa are pierced by a siphuncle, containing, for a short distance, a tubular prolongation of the mantel, which, in the young state, probably forms the main muscular attachment.

Prof. Owen says: "The line of atttachment of both the muscles and the cincture progressively advances with the growth of the animals. A certain portion of the fundus of the shell thus becomes vacated, and the *Nautilus* commences the formation of a new plate, for the support of the part of the body which has been withdrawn, from the vacated shell. The formation of the plate proceeds from the circumference to the center, and there meeting the conical process of the mantel, which retains its primitive attachment, the calcification is continued backward for a short distance, around the process, which now forms the commencement of the membranous siphon, and acquires the partial protection of the calcareous tube. An air-tight chamber is thus formed, traversed by the siphon, which perforates its anterior wall or septum; by a repetition of the same process, a second chamber is formed, included within two perforated septa; and similar, but wider, partitions continue to be added, concurrently with the formation of the new layers, which extend and expand the mouth of the shell, until the animal acquires its full growth, which is indicated by the body having receded, for a less distance from the penultimate septum, before the formation of the last septum is begun."

The fossil shells of this class, found in the Cincinnati Group, appear to have possessed a composition and structure different from that of the shells of any other class. Their peculiarity is manifested by the molecular changes, that seem to have taken place in all parts of the shell—in the siphuncle and septa, as well as in the exterior shell. The appearance presented by the specimens, which show this molecular change, is that of a shell having been melted or softened and run together. Some specimens appear as if the side most distant from the siphuncle had melted down upon it, and then the siphuncle had opened longitudinally and formed a row of nodes on each side of the opening. Flattened specimens of this kind have led to the suggestion, on the part of some, that the shell might have been flat on one side, with the siphuncle on the outside. Other specimens appear as if the siphuncle and septa had melted down upon one side, and others, as if part of the exterior shell had run in upon the septa. These molecular changes seem to have taken place in a high degree in one part of a specimen, while another part remains unchanged. From a knowledge of the foregoing facts, and an examination of numerous specimens of *Orthoceras*, I am led to the conclusion, that all species of this genus found in our rocks are conical shells, having a circular section.

The shells are not porous, like those of the *Brachiopoda*, nor horny, like the *Crustacea*; neither do they present the same appearance, as do the *Lamellibranchiata*, or *Gasteropoda*. The exact difference, however, must be hereafter pointed out, from chemical analysis or microscopical examination. At present, I characterize them as distinct in structure and composition, for the reason, that the shells of no other class appear to have undergone these molecular changes, that present the appearance of the melting and running together of different parts of the shell.

The siphuncle appears in some species of *Orthoceras* to be always central. In other species, however, it appears to cross, from a subcentral or marginal position on one side to the same position on the other. From these facts, I infer, that there can, properly, be no dorsal or ventral side to these shells.

No appearance of muscular scars have ever been noticed on the cast or the shell of the body chamber of any specimen of this class found in our rocks. I have seen a great many good casts of the body chamber of *Orthoceras*, and some good shells of the body chamber, but none of them have shown the least indication of muscular scars. From these facts I have received the impression, that the siphuncle alone was the point of muscular attachment. If this view is correct, then the embryonic state of the *Nautilus* would seem to be the representative of the full developed *Cephalopods* of the Silurian age.

It appears, too, from an examination of some specimens, that several septa were forming at the same time in the body chamber, the anterior ones being only rudimentary, while, posteriorly, they approached nearer and nearer to the siphuncle, or point of muscular attachment.

The method of growth would seem to have been as follows: each septum began to form at the circumference of the shell, near the anterior part of the body chamber, to accommodate the onward growth of the shell, and slowly approached the siphuncle, as it moved forward from septum to septum; the siphuncle being a point of muscular attachment, was not vacated by the animal between any two septa, until the anterior one had been firmly closed by attachment to the siphuncle, forming a chamber of support. The chamber, thus cut off, afterward filled more or less with water, that found its way through the pores of the shell, but otherwise remained firmly closed. For this reason the chambers of the *Orthoceras* are usually filled with crystalline carbonate of lime, while the siphuncle and body chamber are filled with minute fossils, fragments of shells, or uncrystalline matter.

It remains now to be said, that the shells of this class, in our rocks, are very thin in proportion to their size, and that there is nothing to indicate that the animals were powerful or carnivorous, though they might have been carnivorous. The character they have received of "monsters vast of ages past," is not supported by investigation. They were strong enough to sustain themselves among the much smaller animals, with which they associated, and that is the most that can be said of their power.

The *Orthoceratidæ* and the *Cyrtoceratidæ* are the only two families belonging to the *Tetrabranchiata*, represented in the Cincinnati Group, about which there seems to be no doubt. Prof. Meek, however, described a fossil found somewhere about Richmond, Ind., as *Trochoceras Baeri*. If he is right in his genus, it adds to our rocks the family *Trochoceratidæ*, a family not before known to exist in the Lower

Silurian rocks of America. Some specimens have been found in a fragmentary condition, that appear to belong to the family *Gyroceratidæ*, and others that possibly belong to *Phragmoceratidæ*. But I have concluded, because of the doubt about the genera of these latter specimens, to confine this monograph to the first two families above mentioned.

Family *Orthoceratidæ*.

Shell external, straight, conical; divided by numerous septa into closed chambers; last chamber much the largest, for habitation; siphuncle piercing all the chambers, varying in position, from the center to the outer margin, and varying in size and form in the different species.

This family includes the genera *Orthoceras*, *Endoceras*, and *Ormoceras*.

Genus *Orthoceras*—(Breyn).

[*Etym.*—*Orthos*, straight; *keras*, horn.]

Shell conical, straight; greater part of the posterior end traversed by convex, transverse septa; transverse section circular, oval, or more or less triangular; siphuncle cylindrical, or dilated between the chambers, and varying in position from the center to the outer margin; surface smooth, longitudinally or transversely lined.

Orthoceras Mohri—(S. A. Miller).

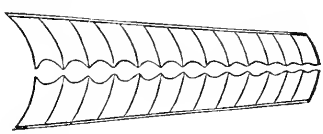

Fig. 10.—*Orthoceras Mohri.* Longitudinal section showing siphuncle.

Shell elongated, tapering very regularly, at the rate of about 0.16 inch to the inch, to an acute point. Septa rather strongly arched, and distant, about one fourth the diameter of the shell. (Measurement of three different polished specimens produced the following result: diameter 0.62 inch, septa distant, 0.15 inch; diameter 0.50 inch, septa distant 0.12 inch; diameter 0.25 inch, septa distant 0.06 inch.) Siphuncle central, and having the appearance of a connected series of oval beads, with the larger ends directed forward, and gradually diminishing in size, as the distance between the septa becomes less and less. Greatest diameter of the siphuncle about or a little more than one fourth the diameter of the shell. Outer chamber more than one fourth the length of the shell, measuring to the end of the siphuncle. Outer surface of the shells in good specimens smooth, and not showing the septa within.

Polished specimens show septa commencing to form in the body chamber, in advance of the siphuncle; those near the siphuncle approaching, while those more distant only commencing to leave the outer shell.

I found this species near Versailles, Ind., about 300 feet below the Upper Silurian rocks, associated with *Anodontopsis Milleri*, *Anomalodonta gigantea*, *Modiolopsis Versaillesensis*, *Cyrtolites ornatus*, showing the outer shell and surface markings, and other fossils better preserved than I have found them elsewhere. The specific name is given in honor of our paleontological friend, Paul Mohr, Sr., Esq.

Orthoceras Dyeri—(S. A. Miller).

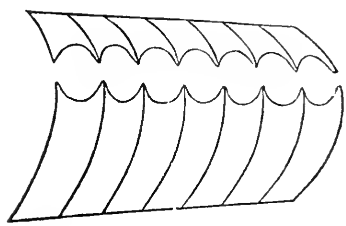

Fig. 11.—*Orthoceras Dyeri*. Longitudinal section showing siphuncle.

Shell rather rapidly tapering; outer surface unknown. Septa highly arched and distant about one fifth the diameter of the shell. Siphuncle large, subcentral, varying in position, and presenting the appearance of a string of flattened oblate spheroidal beads, having the same inclination as the septa, between which they are placed. Greatest diameter of the siphuncle about one-third the diameter of the shell, and therefore more than one and a half times the distance between the septa. Chamber of habitation unknown.

Found on the hills back of Cincinnati, but the range is unknown.

The specimen figured is from the collection of C. B. Dyer, Esq., in whose honor I have given the specific name. The siphuncleis represented in the figure a little narrower than it should be.

Orthoceras Meeki—(S. A. Miller).

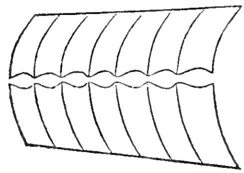

Fig. 12.—*Orthoceras Meeki.* Longitudinal section, showing siphuncle.

Shell medium size, gradually tapering; septa moderately arched, and distant about one seventh the diameter of the shell; siphuncle excentric, or crossing from one side to the other, and consisting of a series of elongate ovate enlargements in each chamber. The greatest diameter of the siphuncle is usually about one half the distance between the septa. The exterior shell and body chamber unknown.

It is here to be observed that in this species the distance between the septa does not always increase as the shell enlarges toward the anterior end, but sometimes one, two, or three chambers will be narrower than their predecessor. Take a number of them, however, together, and a gradual enlargement of the chambers and increased distance between the septa, as the shell increases in diameter, becomes apparent.

Found on the hills back of Cincinnati; range unknown.

Specific name given in honor of Prof. F. B. Meek.

Orthoceras Byrnesi—(S. A. Miller).

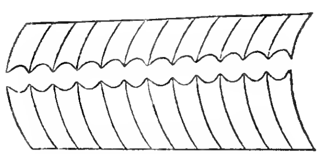

Fig. 13.—*Orthoceras Byrnesi.* Longitudinal section, showing siphuncle.

Shell medium size, very long, and slowly tapering; arch of the chambers about equal to the distance between the septa, and distant about one seventh the diameter of the shell; siphuncle excentric, or crossing from one side to the other, and consisting of a series of slightly ovate enlargements in each chamber. The greatest diameter of the siphuncle is as much or a little more than the distance between the septa, while the septa are pierced with holes about two thirds the diameter of the siphuncle.

The distance between the septa does not always increase uniformly, as the shell enlarges its diameter, but take a large number of chambers, and the increased distance between the septa becomes manifest. It is likely that the increased distance between the septa is more uniform in rapidly tapering shells than in the longer and more slowly changing ones.

Found on the hills back of Cincinnati; range unknown.

Specific name given in honor of Dr. R. M. Byrnes, of Cincinnati.

Orthoceras Fosteri—(S. A. Miller).

Shell large and gradually tapering; septa moderately arched, and distant about one eighth the diameter; siphuncle excentric, enlarging in an oval form in each chamber, and rapidly contracting at its passage through the septa, presenting the appearance of a string of oval beads.

A specimen, having a diameter of $\frac{96}{100}$ inch at the small end, shows 27 septa in a length of 4.25 inches; another specimen, having a diameter of $\frac{86}{100}$ inch at the small end, shows 15 septa in a length of 1.92 inches; and another specimen, having a diameter, at the small end, of 1.50 inches, shows 20 septa in a length of 1.80 inches.

This species most nearly resembles *O. Byrnesi*, but the distance between the septa is less, and the siphuncle proportionally smaller, while the specimens seem generally to be larger.

Found in Clinton county, Ohio, in the upper part of the Cincinnati Group.

Specific name in honor of W. B. Foster, Esq., who has a fine cabinet, and kindly polished many specimens for my examination.

Orthoceras Cincinnatiensis—(S. A. Miller).

Shell medium size, rather rapidly tapering; arch of the chambers about half the distance between the septa, and septa distant about two ninths the diameter of the shell; siphuncle central, excentric, or crossing from one side to the other, and consisting of a series of slightly ovate enlargements in each chamber. The greatest diameter of the siphuncle is a little more than the distance between the septa, while the septa are pierced with holes, about one half the diameter of the siphuncle.

The siphuncle of this species has a very close resemblance to that of *O. Byrnesi*, but the shell tapers more rapidly, and the septa are more distant and less arched.

Found on the hills back of Cincinnati; range unknown.

A very handsome specimen of this species, in the cabinet of C. B. Dyer, Esq., about six inches in length, diameter at the small end $\frac{3}{10}$ths inch, at the large end 1.15 inches, contains forty two chambers.

Orthoceras Halli—(S. A. Miller).

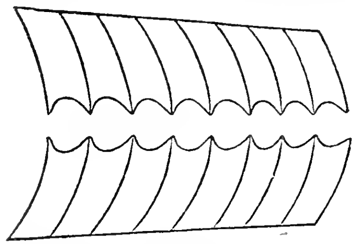

Fig. 14.—*Orthoceras Halli.* Longitudinal section, showing siphuncle.

Shell large, rapidly tapering; septa distant about one sixth the diameter of the shell; siphuncle excentric, or crossing from one side to the other, and consisting of a series of slightly ovate enlargements in each chamber. The greatest diameter of the siphuncle is about one and a quarter times the distance between the septa, while its diameter, where it pierces the septa, is about one half the distance between the septa. Body chamber about one third the length of the shell. Surface unknown.

Found in the upper part of the Cincinnati Group, in Clinton county, Ohio.

The specific name is given in honor of Prof. J. W. Hall, of Covington, Ky., who kindly furnished me his specimens for study. He has one specimen showing the body chamber four inches in length, diameter at the mouth, slightly compressed, two and a half inches, at the rear end two inches (true diameter at the mouth probably not much exceeding two inches). Seventeen chambers, next to the body chamber, are four inches in length; the shell at the seventeenth chamber being a little over one inch in diameter.

Orthoceras Harperi—(S. A. Miller).

Shell medium size, rather rapidly tapering; septa moderately arched, and distant about one ninth the diameter of the shell; siphuncle excentric, or crossing from one side to the other, and consisting of a series of longitudinally depressed ovate enlargements in the chambers.

he greatest diameter of the siphuncle is about one and three fourths the distance between the septa; while the septa are pierced with holes about one half the diameter of the siphuncle. Body chamber and outer shell unknown.

Found on the hills back of Cincinnati; range unknown.

The septa are closer together, and consequently the chambers thinner in this species than they are in any other known to me in the Cincinnati Group. The rapid enlargement of the siphuncle in each chamber is also a noticeable feature.

The specific name is given in honor of my paleontological friend, Prof. G. W. Harper, of Woodward High School.

Orthoceras transversa—(S. A. Miller).

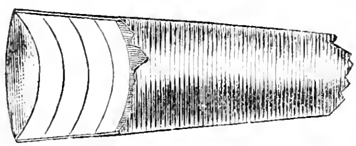

Fig. 15.—*Orthoceras transversa*, showing exterior markings of the shell and curvature of septa.

Shell medium size, rather rapidly enlarging; septa strongly arched and distant about one fourth or one fifth the diameter of the shell; siphuncle excentric, its form not observed; outer shell thin and marked by strong transverse lines, distant from 1-100th to 4-100ths of an inch, in a specimen having a diameter at the large end of three fourths of an inch. The distance between these lines seems to increase as the diameter of the shell increases, but their distance apart is not uniform in different specimens of the same size. About four or five of these transverse lines will mark the distance between the septa, though they do not seem to have any connection with the arrangement of the latter.

This is the only species, except one, known to me in the Cincinnati Group marked on the outer shell with transverse lines. And it is a curious fact, that while with all other species we usually find the chambers and interior part of the shell, and rarely discover the outer shell, yet, with this species it is just the reverse. We usually find the outer shell or a cast marked with transverse lines, and rarely find it in condition to show the chambers or the siphuncle.

Its range, so far as I know, does not extend over 300 feet above low water-mark. I found it in the excavation for Columbia avenue, at 150 feet above low water-mark, and at Eden Park, 200 feet above low water-mark. It is not common by any means.

Orthoceras Ortoni—(Meek, 1872).

Shell rather rapidly expanding, from the posterior toward the aperture; section oval, or more or less nearly circular; septa rather closely arranged; siphuncle lateral, being at one of the narrow ends of the compressed section, but not quite marginal, of comparatively moderate size, and apparently beaded; surface of cast showing traces of regular, obscure, longitudinal ridges, that were probably not defined on the exterior of the shell, which is unknown.

A compressed specimen, 2.30 inches in length, measures at the large end 1.37 inches in breadth one way, and 0.44 inch the other, while, at the smaller end, its greater diameter is 0.38 inch, and its smaller 0.24 inch. The septa at the large end are separated 0.15 inch, and at the smaller end 0.07 inch.

Prof. Meek expresses a doubt as to whether or not this species belongs to the genus *Cyrtoceras.*

Found at Cincinnati; range unknown.

Genus *Endoceras*—(Hall, 1847).

[*Etym.—Endos*, within; and *keras*, horn.]

Shell straight, conical; siphuncle large, usually excentric, smooth, except as marked on the outside by the septa. Within the siphuncle are one or more very elongated conical tubes, often one within another, to the number of four or five.

Endoceras proteiforme—(Hall, 1847).

General form cylindrico-conical, more or less elongated, often compressed, tapering somewhat unequally in different specimens; young specimens terminating in an extremely acute point; surface marked by distinct transverse striæ, which usually appear like narrow subimbricating bands, with one edge well defined and more elevated than the other, more or less distinctly striated longitudinally; striæ varying from extreme tenuity to distinct elevated thread-like lines; section circular; septa distant from one fifth to one fourth the diameter; siphuncle excentric or submarginal.

Its range seems to be co-extensive with the Cincinnati Group, but anything approaching a good specimen is quite rare.

Endoceras approximatum(?)—(Hall, 1847).

Cylindrical, gradually tapering; septa with a convexity little more than one fourth their diameter, distant about one fifth the diameter of the shell; siphuncle large, marginal, obliquely annulated by the thin edges of the septa.

The specimen doubtfully referred to this species I found at Richmond, Indiana. Only part of two chambers are preserved. The siphuncle is two inches in length, and one half inch in diameter, and marked by the edges of the septa, with nine strongly oblique annulations. It will be observed, that the proportions of the specimen do not exactly correspond with the definition of the species; but the siphuncle is almost cylindrical, tapering but very little, and the annulations being quite oblique, it must be very closely related to this species, if not identical.

Family *Cyrtoceratidæ*.

Shell more or less curved on the same plane; siphuncle varying in position; section circular, or sometimes having a transverse or longitudinal diameter the greater; body chamber sometimes expanded, and at other times contracted anteriorly.

Genus *Cyrtoceras*—(Goldfuss, 1833).

[*Etym.—Kurtos*, curved; *keras*, horn.]

Shell curved, or partially involute, sometimes with the transverse, at others the longitudinal diameter the greater; aperture sometimes contracted; siphuncle varying from the center to the concave or convex side.

Cyrtoceras ventricosa—(S. A. Miller).

Shell short, ventricose, gently curved, and very rapidly enlarging toward the aperture; section circular or nearly so; septa slightly concave, and curving forward on the dorsal side, over the siphuncle. Siphuncle close to the shell on the dorsal side, and abruptly expanded within the chambers, forming a cylindrical tube, having a diameter greater than the distance between the septa, and about five times as great as the small circular aperture piercing the septa, through which it passes.

Length of specimen, 2.30 inches; diameter at the small end, 0.44 inch, and at the distance of 0.80 inch from the small end, 0.70 inch.

The specimen being compressed a little at the large end, I can only give the approximate diameter at 1.20 inches. There are fifteen septa in the length of 2.30 inches, and their distance apart increases as the

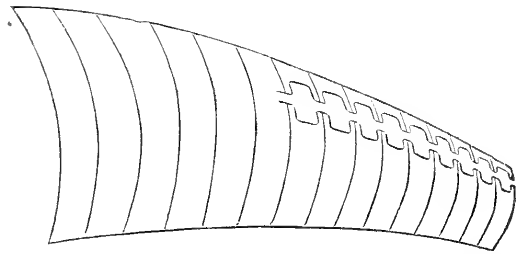

Fig. 16.—*Cyrtoceras ventricosa.* Longitudinal section, showing part of siphuncle.

diameter of the shell increases. The distance between the first two septa at the small end being 0.09 inch, and between the last two septa at the large end, 0.24 inch. The fifth chamber from the small end has a diameter of 0.62 inch; septa 0.13 inch apart; diameter of siphuncle, within the chamber, 0.16 inch, and where it pierces the septa about 0.03 inch.

Surface apparently smooth, though the specimen is not in a condition to definitely determine this point. Chamber of habitation and apex unknown.

I found this specimen and other fragments in the excavation for Columbia avenue, east of Torrence road, in Cincinnati, at an elevation of about 150 feet above low water-mark.

Cyrtoceras obscura—(S. A. Miller).

Shell large, moderately curved, and very moderately enlarging toward the aperture. Section subelliptical, transverse diameter greatest. Septa slightly concave; chambers thin, siphuncle beaded, occasioned by the slight contraction in passing through the septa; situated close to the dorsal side of the shell; diameter about three times as great as the distance between the septa. Shell slightly contracted at the posterior end of the chamber of habitation. Chamber of habitation and surface unknown.

Specimen showing part of the chamber of habitation and fifteen septa. Length of fifteen septa on the dorsal side, 3.40 inches; ventral side, 2.18 inches. Transverse diameter of the small end, 2.54 inches; of the chamber habitation, 2.90 inches. Diameter of siphuncle, 0.52 inch.

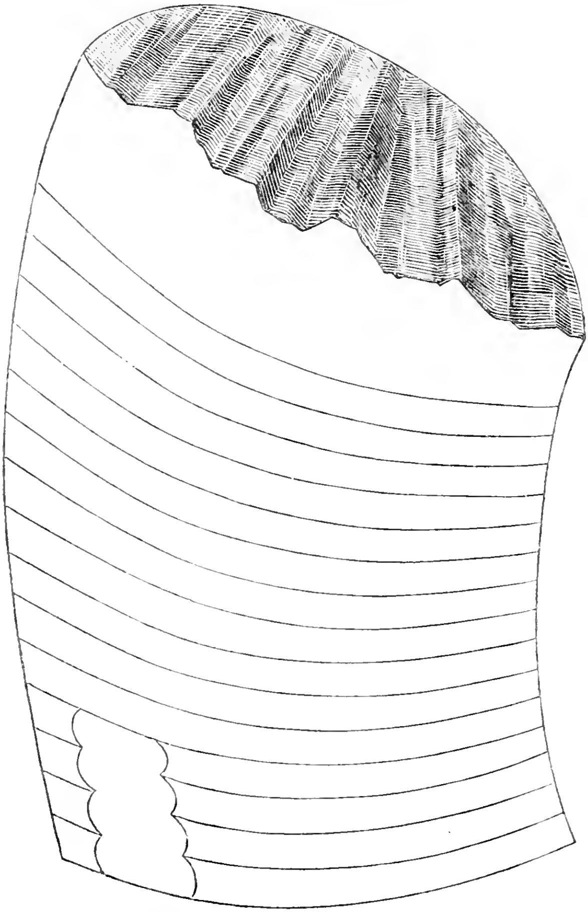

Fig. 17.—*Cyrtoceras obscura.* Longitudinal section showing part of the siphuncle.

I found this specimen in the first ward of Cincinnati, about 130 feet above low water-mark.

For *Cyrtoceras Vallandighami* (S. A. Miller), see vol. i., p. 232, of this Journal, July, 1874.

Trochoceras (?) Baeri—(Meek and Worthen, 1865).

Shell sub-discoidal, consisting of about two or three rather rapidly enlarging volutions, which are more broadly rounded on the outer surface than on each side, and about one fourth wider transversely than the dorso-ventral diameter; each inner volution slightly impressing the inner side of the succeeding turn. Umbilicus a little more than half the dorso-ventral diameter of the outer volution, and showing all the inner turns. Spire apparently scarcely (or perhaps not) rising above the upper surface of the last turn. Septa rather distinctly concave on the side facing the aperture; separated on the outer side of the whorls (at a point where the dorso-lateral diameter is about 1.25 inches) by spaces measuring 0.35 inch; all showing a very slight backward curve on the broadly rounded periphery, and passing nearly straight across each side. Surface, siphuncle and non-septate part of the shell not certainly known.

Greatest breadth of the typical specimen (which is septate) to the broken outer extremity 5 inches; height or thickness of same about 2.50 inches. Dorso-ventral diameter of the volutions increasing about three fold each turn.

The locality given for this species in the *Ohio Paleontology* is the upper part of the Cincinnati Group, at Richmond, Indiana, and in Warren and Clinton counties, Ohio, but I have never heard of any other specimen than the single one found somewhere about Richmond, Indiana.

Review of the Present State of the Controversy Concerning the Motion of Glaciers. By Prof. E. W. Claypole, B.A., B.S., of Antioch College, Yellow Springs, Ohio.

In the first part of this paper published in January last, a short sketch was given of various theories that have been at different times put forward to account for the motion of a glacier. In all of them the ice was supposed to move as ice, and the efforts of their authors were directed to the discovery of some source of power existing in the glacier, or acting on it, from without, that would be sufficient to produce the movement observed.

De Saussure, Rendu and Forbes thought they had found this in the weight of the ice—that is, in gravitation. De Charpentier and Moseley on the other hand, brought in the additional agency of heat. The demonstration of the high unit of shear possessed by ice refuted the theory of Rendu and Forbes, or rendered necessary some great modifications; DeSaussure's hypothesis was untenable on mechanical grounds, and the discovery by Aggasiz of the almost unvarying temperature of the interior of a glacier made the acceptance of the suggestion of DeCharpentier and of Canon Moseley alike impossible.

The important fact established by the investigations of the last named writer — the high shearing force of ice — raised a new and formidable difficulty in the way of theorists upon this subject, which it was necessary in some way to evade or to overcome. Accordingly, the most recent suggestion is founded upon a completely different principle. It is equally novel and ingenious, and comes from the pen of Mr. Jas. Croll, now, and for some years past, engaged on the Geological Survey of Great Britain. Instead of seeking a force sufficient to overcome the high resistance of ice to shearing, he believes that he has found in heat a means of undermining that resistance, and thus, of enabling gravitation, unaided, to produce the movement.

The papers embodying these views appeared in the *London, Edinburgh and Dublin Philosophical Magazine*, for March, 1869, and September, 1870. In the earlier number, Mr. Croll says:

"Although it is demonstrated that glaciers can not descend by means of their weight alone, in the manner generally supposed, still I venture to think, that notwithstanding the demonstration, gravitation, after all, may be the only force moving the ice.

"The correctness of the above conclusion — that the weight of the ice is not a sufficient cause—depends upon the truth of a certain element taken for granted in the reasoning, that the shearing force of the molecules of ice remains constant. If this force remains constant, then Canon Moseley's conclusion is undoubtedly correct, but not otherwise; for if a molecule should lose its shearing force, though it were but for a moment, if no obstacle stood in front of it, it would descend in virtue of its weight.

"The fact, that the shearing force of a mass of ice is found to be constant, does not prove that the same is the case in regard to the individual molecule. If we take a mass of molecules in the aggregate, the shearing force of the mass taken thus collectively may remain absolutely constant, while at the same time each individual molecule may be suffering repeated momentary losses of shearing force. This is so obvious as to require no further elucidation. The whole matter therefore resolves itself into this one question, whether or not the shearing force of a crystalline molecule of ice remains constant. In the case of ordinary solid bodies we have no reason to conclude that the shearing force of the molecules ever disappear, but in regard to ice it is very different.

"If we analyze the process by which heat is conducted through a mass of ice, we shall find that we have every reason to believe that while a molecule of ice is in the act of transmitting the energy received (say, from a fire) it loses for the moment its shearing force, if the temperature of the ice be not under 32° Fah. If we apply heat to the end of a bar of iron, the molecules at the surface of the end have their temperature raised. Molecule *A*, at the surface, whose temperature has been raised, instantly commences to transfer to *B* a portion of the energy received. The tendency of this process is to lower the temperature of *A* and to raise that of *B*. *B*, then, with its temperature raised, begins to transfer the energy to *C*. The result is then the same. *B* tends to fall in temperature and *C* to rise. This process goes on from molecule to molecule, until the opposite end of the bar is reached. Here, in this case, the energy or heat applied to the end of the bar is transmitted from molecule to molecule, under the form of *heat or temperature*. The energy applied to the bar does *not change its character, it passes right along from molecule to molecule, under the form of heat or temperature*. But the nature of the process must be wholly different if the transferrence takes place through a bar of ice at the temperature of 32°. Suppose we apply the heat of the fire to the end of a bar of ice at 32°, the molecules of the ice can not possibly have their temperatures raised in the least degree. How, then, can molecule *A* take in, *under the form of heat*, the energy received from the fire without being heated or having its temperature raised? The thing is impossible. The energy of the fire must appear in *A* under a different form from that of heat. The same process of reasoning is equally applicable to *B*; the molecule *B* can not accept of the energy from *A* under the form of heat, it must receive it under some other form. The same must hold equally true of all the other molecules, till we reach the opposite end of the bar of ice. And yet, strange to say, the last molecule transmits in the form of heat its energy to the objects beyond; for we find that the heat applied on one side of a piece of ice will affect the thermal pile on the other.

"The question is susceptible of a clear and definite answer. When heat is applied to a molecule of ice at 32°, the heat applied does not raise the temperature of the molecule, it is consumed in work against the cohesive forces which bind the atoms or particles together into the crystalline form. The energy, then, must exist in the dissolved crystalline molecule under the statical form of an affinity—crystalline affinity—or whatever else we may call it. That is to say, the energy then exists in the particles as a power or tendency to rush together again into the crystalline form, and the moment they are allowed to do so they give out the energy that was expended upon them in their separation. This energy, when it is given out, again assumes the dynamical form of heat; in other words, the molecule gives out *heat* in the act of freezing. The heat then given out may be employed to melt the adjoining molecule. The ice molecule takes on energy from a heated body by melting. That peculiar form of motion or energy, called heat, disappears in forcing the particles of the crystalline molecule separate, and for the time being subsists on the form of a tendency in the separated particles to come together again into the crystalline form.

"But it must be observed that although the crystalline molecule when it is acting as a conductor takes in energy under this form from the heated body, it only exists in the molecule under such a form during the moment of its transmission, that is to say, the molecule is melted, but only for a moment. When *B* accepts the energy from *A*, the molecule *A* instantly assumes the crystalline form. *B* is now melted, and when *C* accepts of this energy from *B*, then also *B* in turn assumes the solid state. This process goes on from molecule to molecule, till the energy is transmitted through to the opposite side and the ice is left in its original solid state. This is the *rationale* of Faraday's property of regelation.

"This point being established, every difficulty regarding the descent of a glacier entirely disappears; for a molecule, the moment it assumes the fluid state, is completely freed from shearing force, and can descend by virtue of its own weight, without any impediment. All that the molecule requires is simply room or space to advance in. If the molecule were in absolute contact with the adjoining molecule below, it would not descend, unless it could push that molecule before it, which it probably would not be able to do. But the molecule actually has room to advance in, for, in passing from the solid to the liquid state, its volume is diminished by about one tenth, and it consequently can descend. True, when it again assumes the solid state, it will regain its former volume; but the question is, will it go back to its old position? If we examine the matter thoroughly, we shall find that it can not. If there were only this one molecule affected by the heat, this molecule would certainly not descend, but all the molecules are similarly affected, although not all at the same moment of time.

"Let us observe what takes place, say, at the lower end of the glacier. The molecule *A*, at the lower end, say, of the surface, receives heat from the sun's rays; it melts, and in melting not only loses its shearing force and descends by its own weight, it contracts also. *B*, immediately above, is now, so far as *A* is concerned, at liberty to descend, and will do so the moment that it assumes the liquid state. *A*, by this time, has become solid, and again fixed by shearing force, but it is not fixed in its old position, to but a little below where it was before. If *B* has not already passed into the fluid state in consequence of heat derived from the sun, the additional supply which it will receive from the solidifying of *A* will melt it. The moment that *B* becomes fluid it will descend until it reaches *A*. *B*, then, is solidified a little below its former position. The same process of reasoning is in like manner applicable to every molecule of a glacier. Each molecule of a glacier, consequently, descends step by step as it melts and solidifies, and hence, the glacier, consolidated as a mass, is in constant motion downward."

Mr. James Geikie, F.R.S., in his recent work, "The Great Ice Age," thus speaks of Mr. Croll's hypothesis, after sketching its principal features:

"Heat is thus the great lever which forces the hard masses of compacted snow and ice from higher to lower levels, and relieves the mountains of their loads of frozen water. If it were not for that peculiar property of ice, which enables it to behave in many respects like a viscous or semi-fluid body, all the waters of the earth, the myriad rivers, and lakes, and seas, would gradually be lifted up by the heat of the sun and carried on the wings of the wind to the mountains, there to accumulate in vast and constantly growing masses, until ocean and all its feeders had been exhausted. But the heat of the sun, which, falling upon clay, sand, or solid rock, merely raises the temperature, without changing the condition of these masses, pulses through the great piles of ice that cumber the higher elevations of Alpine countries. The temperature of the ice itself can not rise, but every atom of its bulk is set in motion, and slowly and gradually the solid heaps creep down hill-slope and valley, their progress being accelerated or retarded according to the degree of heat acting upon and passing through them. It is thus that during day the downward movement of the ice is less sluggish than at night, and for the same reason a glacier in summer moves more quickly on its way than in winter, when its motion is exceedingly slow, sometimes not reaching to half the summer rate.

"The motion of ice, then, being due to the transmission of heat, which, by momentarily converting into water each molecule of the frozen mass, in succession allows it to descend by gravitation, it is quite evident that a body of ice will move down any slope, however gentle the inclination may be. Its motion is precisely that of running water, and hence we need not be surprised to find it stealing slowly down inclinations which are so slight as to appear to the eye like level plains.

"But it may be asked, how it happens that a body built up of atoms which are constantly passing from the solid to the liquid state, and *vice versa*, nevertheless retain an unvarying hard and brittle condition. This is due to the property of regelation. When two fragments of ice at 32° are brought into contact, they instantly unite to form one solid piece. What is, then, true of ice in the mass, is equally true of its most minute atoms. Whenever these impinge upon one another, they immediately freeze firmly together. No sooner does a molecule, which has momentarily melted, resume the solid state, than it immediately unites to the other solid particles by which it is surrounded; hence the continuity of the whole is preserved, and throughout its entire bulk the ice remains a solid body. Such is the ingenious theory advanced by Mr. Croll."*

Mr. Croll's hypothesis, then, briefly is this, that the glacier moves not as ice, but as water, during the constant though momentary liquefaction of its particles, one after another, and that this liquefaction is caused by the transmission of heat into the ice from without, in the form of a liquid wave, the substance being incapable of conveying this motion and at the same time of retaining its solidity.

In considering this theory, it will be well to define it at the outset a little more clearly.

In the first place it is evident that the only kind of heat really involved in the hypothesis is that which is carried into the interior of the glacier by the process of conduction. Radiant heat, as it enters and passes through the ice, is not concerned directly in the production of the motion. We will, however, consider this subject further on, taking into account at present only the heat of conduction.

Now, in order that conduction of heat may occur between two bodies, the first and essential condition is, that they *must be of different temperatures*. The greater this difference, the more rapid the conduction, and *vice versa*. A heated cannon ball cools rapidly at first, even in its interior, and then more and more slowly, as its temperature falls, until equilibrium is established, when all conduction ceases. Applying this fact to the theory in question, we have three bodies: overlying air, the superficial layer of ice, and the glacial mass below. Of these three, the last is almost invariable in temperature, while the first varies widely between day and night, summer and winter. The second holds an intermediate position, and forms a transition link. It receives heat by conduction from the air at one time, and gives it up at another. But it is subject to the limitation that it can not be raised

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* The Great Ice Age, p. 41.

to a higher temperature than 32°.* As soon as that point is reached, it melts and flows down as water. Consequently, there always intervenes between the warm air and the mass of a glacier this superficial film or layer of inconsiderable thickness, which acts as a barrier to the free passage of conducted heat into the ice, and introduces a serious, if not a fatal, objection to Mr. Croll's hypothesis. For we have just at the point where he supposes conduction to take place, the exact conditions that render it impossible. Instead of two bodies of widely different temperature, we have two whose difference in that respect is infinitesimally small. The one—the mass of the glacier—is never perceptibly below 32°. The other—the superficial layer of water of melting ice—never rises above that point. The physical difference between them—ice and water—is striking; but this difference does not require more than an infinitesimal thermometric variation. The heat of liquidity, though immense in amount, produces no effect on the temperature, and can not, consequently, give rise to any wave of conduction between the two.

It will no doubt be said in reply, that, as a fact, heat *is* conducted into the interior of ice, and shows itself by melting the ice at a distance from the surface. The experiments of Prof. Tyndall have conclusively determined this, and in so far seem to lend countenance to the theory. "A piece of ice containing liquid cavities was placed in a freezing mixture, and the liquid bubbles frozen; it was then wrapped in flannel and placed in a dark room, to exclude the effects of radiation. Nevertheless, in two hours the liquid cavities were completely restored by heat, which had been conducted through the substance without visible prejudice to its solidity." †

That ice, therefore, like all other substances, is capable of conducting heat, is indubitable; but this same experiment of Prof. Tyndall's shows the impossibility of accounting for the motion of a glacier by means of this conduction. Though experiments are still wanting to determine the exact conductivity of ice, yet it is certainly very low. The greatest distance to which the heat was conducted was a quarter of an inch, namely, to the middle of a half-inch plate of ice, and this occupied two hours.‡

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* We lay out of consideration all passage of heat outward, and also all transmission inward, when the surface has a temperature of less than 32°, because in neither case can the effects concern the question at issue.

† Heat as a Mode of Motion, p. 318.

‡ In this exceedingly low rate of conductivity we can see the reason for the slightness of variation in the temperature of a glacier. Unable to rise perceptibly above 32° from its physical constitution, the ice is also unable to conduct the heat of its channel away fast enough to fall much below it, and, consequently, observations have never shown a lower temperature than about 31.5° Fah. It is impossible, therefore, to admit, as Mr. Croll's theory requires, that the ice of a glacier can conduct into its *mass from a superficial layer of nearly its own temperature* sufficient heat to produce any sensible effect at depths exceeding a few inches or feet.

Instead of "pulsing through the great piles of ice," as Mr. Geikie says, the small amount of heat that may succeed in entering the mass crawls along at a rate almost imperceptible. If we assume the velocity of transmission shown in Tyndall's experiment—a quarter of an inch in two hours, or three inches per day—a whole year must pass before the first wave of summer heat can penetrate the glacier to a depth of 90 feet, or, in other words, if the Alpine summer continues for 160 days, its effects can not be felt at a greater depth than 40 feet before the ensuing winter changes the direction of the current.

But not only does the acceptance of Mr. Croll's theory require the admission of these two physical impossibilities—the ready conduction of heat from one body to another of the same temperature, and its ready transmission through one of the worst conductors known—but it also assumes, as one of its fundamental propositions, that ice can not rise in temperature above 32°, even to the slightest extent, without becoming liquid. This is, we think, not only unproved, but contrary to probability. In speaking of the experiment above mentioned, Prof. Tyndall says:

"The heat of a body is referred at the present day to a motion of its particles. When this motion reaches an intensity sufficient to liberate the particles of a solid from their mutual attraction, the body passes into the liquid condition. Now, as regards the amount of motion necessary to produce this liberty of liquidity, the particles as the surface of a mass of ice must be very differently circumstanced from those in the interior, which are influenced and controlled on every side by other particles. But if a cavity exist within the mass, the particles bounding that cavity will be in a state resembling that of the particles at the surface, and by the removal of all opposing action on one side the molecules may be liberated by a force which the surrounding mass has transmitted without prejudice to its solidity, just as the last of a series of elastic balls is detached by a force which has been transmitted by the other members of the series, without visible separation."

Prof. Tyndall here evidently suggests the possibility of the conduction of heat through a mass of ice without melting it, in consequence of the restraint imposed upon the inner particles by the close presence of neighboring ones. This, it can not be doubted, involves the possibility of raising its temperature above 32°, if only by a minute fraction of a degree. But even the fraction of a degree is sufficient, and more than sufficient, to enable the ice to convey away, "without prejudice to its solidity," the infinitesimally small amount of heat which can be transmitted into it from a film of overlying water at 32°.*

It may also be worth while to observe in passing, though not as affecting the theory in question, that the bottom of a glacier *must have a temperature lower than* 32°, on account of the weight of the overlying mass. The experiment of Prof. W. Thomson of Glasgow, in 1849, showed that the melting point of ice is lowered about 0.013° for every additional atmosphere brought to bear upon it. Assuming, then, the weight of glacier ice at 56 lbs. per cubic foot, the pressure will increase at the rate of nearly one atmosphere for every 40 feet of depth. Consequently, at a depth of 400 feet, when a pressure of 10 atmospheres, or 150 lbs., on the square inch would be reached, the melting point of ice would be not 32° but 31.87°, and if the bottom of the glacier lay at this depth the lower surface must melt whenever that point is attained. This is the origin of the stream which issues in winter from beneath the ice. The heat of the earth melts the ice in contact with it, and keeps it in a constantly thawing condition, though its own surface is below 32°. Were it not that a great part of the water thus produced solidifies again, as soon as released from the pressure, these winter streams would be larger than they are.

Though not logically concerned in Mr. Croll's theory, it may be as well also to consider the effect of radiant heat upon the ice of a glacier. That radiant heat passes into ice more rapidly than the heat of conduction is of course true. But even here we fear Mr. Croll's theory has little to expect. The intensity of solar heat among the Alpine glaciers is matter of constant remark from travelers in Switzerland. "I scarcely ever," says Forbes, "remember to have found the sun more piercing than at the Jardin." On this Mr. Croll himself remarks: "there is no proof from this that the glacier experiences any change of temperature. The sun shines down with piercing rays and the traveler is scorched, the glacier melts on the surface, but it still remains cold as ice. The scorching rays are withdrawn and the traveler is subjected to radiation on every side, *from* (query *to*) surfaces at the freezing point."†

It may, at first sight, seem that so great an amount of solar heat, falling directly upon a glacier, must have some effect upon it; but a little consideration of the properties of ice toward radiant heat is sufficient to dispel the illusion. Notwithstanding the transparency

* It is not antecedently more improbable that ice should be capable of existing at temperatures slightly above 32°, than that water should be capable of remaining liquid in certain circumstances at temperatures below the freezing point, which is a thing of constant occurrence.

† *L. E. and D. Phil. Mag.*, Sept., 1870.

of ice, its diathermancy is exceedingly low. Melloni has shown, that of the light and heat radiated from a lamp, and falling on the surface of a plate of ice one tenth of an inch in thickness, 94 per cent. is absorbed, and only 6 per cent. emerges from the opposite fall, while of the total radiation of incandescent platinum only *one half per cent.* is transmitted through such a plate. Ice is, in fact, one of the most impervious substances known to the obscure or peculiarly calorific rays, and while their can be no doubt that the shorter and more luminous vibrations can and do pass into the mass of the glacier, perhaps to its very base, it is equally certain that the longer and less luminous ones fail to penetrate it to any appreciable distance. They are almost wholly absorbed in warming the superficial layer, if below 32°, and in melting it if not below.* Hence, the surface of a glacier when exposed to the sun's rays is soft, the ice is called "rotten." Stream of ice cold water runs over it in every direction, and the level of the glacier sinks by "oblation," sometimes amounting to eight or nine feet in the year.

The only effect of the solar radiation, therefore, is to aid in producing the intermediate layer, of which mention was made above—a layer whose temperature seldom exceeds 32°, which is constantly being renewed by liquefaction, as fast as it is removed, and from which, on Mr. Croll's theory, incessant waves of liquidity are passing into a mass of ice *of the same temperature as itsef.*

Another very large deduction must be made from the heat supposed by Mr. Croll to be thus freely conducted into a glacier. The structure of the ice is such, that it is full of blebs and cracks, all affording *internal surfaces*, on reaching which the heat (admitting its free transmission) will spend itself in melting the ice upon these surfaces and enlarging the cavities, so as to aid the heat of radiation in reducing the superficial layer to a crumbling mass of several inches in thickness, and feeding the rivulets that trickle over and through the glacier in summer time. It is hardly possible that if any appreciable amount of heat should succeed in entering the mass, it could escape meeting on its passage with one of these cavities, where it would necessarily cease to become *heat of temperature*, and become latent as *heat of liquidity.* Moreover, Mr. Croll's illustration of his own theory is open to a charge of partiality. He says:

"Let us observe what takes place, say, *at the lower end of a glacier.*" He then supposes the tranfer of heat *upward*, melting each molecule

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* The intense blue color of the ice, when seen from below, is due to the absorption of the longer rays by the superficial layers, while the shorter (blue) ones are able to penetrate almost unchecked. This effect may also be increased to some extent by fluorescence.

L. E. and D. Phil. Mag., March, 1860.

in succession, and reducing it to a lower level, so as to make room for the descent of the next above, as soon as it has become liquid by the receipt of energy from its resolidified predecessor, now again fixed by cohesion at a lower level. But, we may ask, does the heat (supposing it to enter the ice) enter at the *lower* end of a glacier and pass *upward* toward its névé? On the contrary, if it pass into the ice at all, it must do so from the surface, and be transmitted vertically *downward*. Consequently, the melted molecule can not descend *before* it passes on its heat of liquidity to the next *below* it. It has no room to fall in. Its own contraction or melting will leave a space *above* it temporarily vacant. But the particle above it is already solid, and can not fall into that cavity, and before it can pass on its energy to the molecule below it, it must surrender that energy itself. The heat, and, consequently, the liquidity, can not exist in two molecules at the same instant of time. It must pass from the upper one before it can be possessed by the lower one. But in passing from the upper one it must cause that molecule to solidify *exactly in the position it previously occupied.* By re-solidifying it would fill again the vacuity temporarily produced by its liquefaction, and the same process would take place in the succeeding particle. No downward motion, therefore, can be produced. The molecules can not flow while in their supposed liquid condition, for want of space, and when space is given to them by the liquefaction of the molecule below, they can not descend, because they are again chained by cohesion, needing *shearing force* to overcome it, which is not present. On a fair application, therefore, of Mr. Croll's own illustration, his theory fails to account for a phenomenon which he explains by special pleading in one particular and favorable instance.

Having thus discussed some of the most important physical facts, which Mr. Croll seems to have entirely overlooked, in their bearings upon his theory, we propose now to follow it into some of its obvious results, in order to determine how far it fulfills the first great condition of every hypothesis—adequacy to account for the phenomena observed.

There can be no doubt that if we admit Mr. Croll's premise, that successive layers of the ice become momentarily liquefied, and during that short interval flow down to a lower level, we shall obtain a molecular movement of the glacier downward. This result is *entirely* due to the weight of the molecule itself, unaided from without. Mr. Croll does not admit or require any downward pressure of the mass of the glacier above it. Every particle flows in the glacier exactly as it would flow in a river, with the single exception that its flow is *intermittent.* It would follow, therefore, that the different parts of the glacier must move at different rates, and that these rates will be determined by the amount of heat which each part receives. A region exposed to the sun's rays must, therefore, move faster than a region sheltered from them, inasmuch as it is constantly covered by a film of water, from which Mr. Croll supposes the heat to be conducted. This, however, is not the case. In the Mer de Glace the rate of movement increases gradually from the higher parts to the lower. The glacier, in fact, moves as a whole, and not molecularly; with a differential motion, it is true, but not with such a differential motion as Mr. Croll's theory requires, and the result of the motion of the whole is, that its central and superficial portion is carried along at the rate of about a yard per day.

This, however, is only true of the glacier as a whole. A cubic yard cut out of the more swiftly moving part, and laid upon the rock beside it, would show no more motion than the rock itself, though exposed to the same access of heat. Yet, on Mr. Croll's theory, both should comport themselves alike. Indeed, if the principle upon which his hypothesis is founded were correct, any lump of ice exposed to a heat above 32° should soften and flow outward, until it had spread itself into a thin layer, without melting, except at the surface. Nor is there any reason for limiting this result to the rate observed on the Mer de Glace. Still greater mobility might be looked for, and ice must be more plastic than butter to bring about the necessary consequence of Mr. Croll's principle. It is needless to add, that such results are never observed. A lump of ice, even in summer, shows no tendency to spread thus; and if the absence of viscosity has proved a stumbling-block in the way of Forbes' Viscous Theory, the absence of all evidence of liquidity is an equally fatal objection to Mr. Croll's Liquid Theory. Again, it is impossible to admit that a glacier, moving as on this Liquid Theory it is supposed to move, can scratch and groove the rock-bed over which it passes as glaciers are known to do. Mr. Croll, it is true, claims this as a legitimate result of his theory, when he says:

"As regards the denuding power of glacier, I may observe that though a glacier descends molecule by molecule, it will grind the rocky bed over which it moves as effectually as it would do did it slide down in a rigid mass in the way generally supposed, for the grinding effect is produced not by the ice of the glacier but by the stones, sand, and other material forced along under it. But if all the resistances opposing the descent of a glacier, internal and external, are overcome by the mere weight of the ice alone, it can be proved that in the case of one descending with a given velocity, the amount of work performed in forcing the grinding materials lying under the ice forward, must be as great, supposing the motion of the ice to be molecular in the way I have explained, as it would be supposing the ice descended in the manner generally supposed." * But this claim of Mr. Croll on behalf of his theory can not be admitted. As long as the glacier moves *as ice*, it is perfectly easy to admit that it may hold stones and sand firmly enough to cause them to score the rocks in its channel rather than to slip from its grasp. But when the glacier is supposed to descend molecule by molecule, and not as ice, but as water, it is impossible to believe that such action is any longer possible. The material carried down by a river never polishes or grooves its channel, if consisting of rock, and the Liquid Theory imagines the glacier to flow down as a river flows, with the sole difference, that its particles move singly, slowly, and intermittently, rather than concurrently fast, and continuously. Moreover, this very objection has always proved a formidable obstacle to the acceptance of Forbes' theory. The slight degree of viscosity demanded by its fundamental principle made it difficult to admit the possibility of such results as grooving and striation. It is not, therefore, necessary to dwell upon the enhancement of the same difficulty that is introduced by the Liquid Theory in question.

Mr. Croll further adds:

"We have in this theory a satisfactory explanation of the origin of crevasses in a glacier. Take for example the transverse crevasses formed at a point where an increase in the inclination of the glacier takes place. Suppose a change of inclination from 4° to 8° in the bed of the glacier. The molecules on the slope of 8° will descend more rapidly than those above on the slope of 4°. A state of tension will therefore be induced at this point, where the change of inclination occurs. The ice on the slope of 8° will tend to pull after it the mass of the glacier moving more slowly in the slope above. The pull being continued, the glacier will snap asunder the moment that the cohesion of the ice is overcome. The greater the change of inclination, the more readily will the rupture of the ice take place."

Mr. Croll has here fallen into the logical fallacy, so common with the advocate of new theories, of specially quoting, in his own support, a phenomenon that is almost equally favorable to all the hypotheses that have been put forward to account for the movement in question. Even if the claim be admitted, it would form no argument in defense of the Liquid Theory, because, it may be made with equal show of reason by the followers of Forbes, and with yet more justice by the

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* *L. E. and D. Phil. Mag.*, March, 1869.

adherents of Moseley, De Charpentier, and De Saussure. But, like the last, this claim can not be allowed. No difficulty lies in the way of admitting the crevasse as a necessary result of any theory that supposes the glacier to move *as ice*, but the moment this ground is abandoned, and the rigidity of the material in any way removed, the crevasse becomes a standing obstacle, that has thus far defied removal. Readers of Forbes' writings upon the subject know well with how much ingenuity and labor he has striven to clear it away, as though fully aware of its fatal character, and they must also have felt how little success he attained in the effort. The two seem irreconcilable —viscosity and brittleness. If the ice is plastic enough to flow, how can it be brittle enough to allow yawning crevasses, hundreds of feet deep, to form and grow within it? And if this phenomenon applied with such force against the viscous theory, with how much greater force must it assail the liquid theory of Mr. Croll? According to his own explanation of it, no sooner is a crack formed than the heat gains access to the new surface, and passing into the ice, must produce the same effect as at any other surface, and cause a downward motion of the momentarily liquified particles, which must again close the opening and stifle the crevasse at its very birth. A glacier, moving as Mr. Croll supposes, can neither produce grooves on its channel, nor allow crevasses on its bosom, but must *flow* onward, without more friction at its base and with less unevenness on its surface than a river of water. It is evidently impossible to admit a successive molecular liquidation, which can produce a flow of 36 inches per day down a slope of 8°, and at the same time a hardness capable of maintaining vertical walls of ice hundreds of feet in height.

Mr. Croll has, it may be noticed, only quoted an example of a crevasse formed by a change of interlineation in the bed of a glacier, which is a comparatively easy problem. He has made no attempt to claim, in support of his theory, the far more difficult case, where crevasses develop themselves along and across the mass while moving over an unchanging slope, such as margined crevasses. On his theory, it would be almost as reasonable to expose the formation of such chasms in the surface of a river as on that of a glacier of constantly melting ice.

Is it possible, we may further ask, to account for the downward movement of moraines and other foreign substances lying on the surface of a glacier, or buried in its mass, on the theory of Mr. Croll? This is a necessary result of assuming its movement *as ice*, but it seems quite incompatible with the admission that it must become liquid as the condition of motion. In the case of an erratic block lying upon its surface, the slight friction of the molecules, as they successively thaw and glide downward by infinitesimally small steps, would be quite incompetent to communicate their motion to the underlying mass of stone. A stake set firmly in the ice must in the same way be left behind, as the momentarily liquified particles steal past it with no more friction than that of the water in a river against the trunk of a tree upon its bank. Instead of recording, as in fact they do, the daily and hourly flow of the glacier, they would remain permanently where at first they had been set. And the bodies of victims who have the misfortune to fall into the depths of some yawning crevasse, instead of reappearing at the foot of the glacier after an interval of twenty, forty, or eighty years,* would remain forever sealed up where they fell, while the liquid molecules successively slide past them. In this respect, also, it is impossible to reconcile the consequences which would flow from Mr. Croll's theory with the well known facts of glacial nature. In yet another point is this theory irreconcilable with fact. The motion of a glacier, it is well known, is not uniform, but differential. The surface moves more rapidly than the parts below, and the middle more rapidly than the sides. But if, as Mr. Croll maintains, the entrance of heat and its conduction through the mass of the ice, as a wave of liquidity, is the sole and sufficient cause of the movement, the results produced would not accord with the observations. The upper layer may be supposed to move faster than the lower without inconsistency, but theory would certainly require that the side should move faster than the middle. There can be no reason for supposing that a liquid molecule near the margin has any greater difficulty in moving down the slope than a liquid molecule in the middle. Each is surrounded by other molecules in the solid state, each has the same degree of friction to overcome, and the same interval of time for accomplishing its movement. But the ice at the margin of the stream being thinner than that in the middle, is more thoroughly under the influence of the heat, which would less slowly penetrate it, and would be then reflected from the rocky bed, consequently, every particle must pass more often into the liquid form, and for this reason should travel faster than the particles lying in mid-stream.†

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* The remains of the guides lost in 1820, in Dr. Hamel's attempt to cross Mt. Blanc, were found imbedded in the ice of the glacier des Bossons, in 1863. The men and their things were torn to pieces and widely separated. All around them the ice was covered in every direction, for twenty or thirty feet, with the hair of one knapsack, spread over an area three or four hundred times greater than that of the knapsack." This, says Mr. Crowell, is not an isolated example of the scattering that takes place in or on a glacier. I myself saw, on the Theodule glacier, the remains of the Syndic of Val Tournanche scattered over a space of several acres."

† The more rapid flow of a river in the middle does not invalidate this argument. The water in a river is all subject to the same moving force—gravitation—everywhere equal in amount. But Mr. Croll's theory obliges us to admit that the ice along the margins of a glacier is in much more complete subjection to the influence of heat than is that in the middle, and, consequently, possesses what is equivalent to a greater motive force.

Mr. Croll has very satisfactorily shown from Canon Moseley's own data, that the theory of expansion fails to give the motion required in summer, by observation. He says:

"It is a necessary condition of Mr. Moseley's theory that the heat should pass easily into and out of a glacier, for unless this were the case, sudden changes of temperature could produce little or no effect on the great mass of the glacier. How, then, is it possible that during the heat of summer the temperature of the glacier could vary much? During that season, in the lower valleys at least, everything, with the exception of the glacier, is above the freezing point; consequently, when the glacier goes into the shade, there is nothing to lower the ice below the freezing point, and as the sun's rays do not raise the temperature of the ice above the freezing point, the temperature of the glacier must (therefore) remain unaltered during that season. It follows, therefore, that instead of moving more rapidly during the middle of summer than during the middle of winter, the glacier should, according to Moseley's theory, have no motion whatever during summer.*

But is not the same condition equally necessary for Mr. Croll's theory, viz.: the ready transmission of heat into the mass of a glacier, in whatever form that heat may pass? We have already shown that the low conductivity of ice excludes this condition, and, consequently, invalidates the theory. Granting, what is probably true, that during the summer a small amount of heat penetrates to a slight depth the glacial mass, the approach of night, or winter, reverses the case, and then, instead of absorbing, the ice gives out the heat it had already taken in, and its superficial temperature falls below the freezing point. In these cirumstances no conduction of heat into the interior is possible, and radiation from without, if it were appealed to for aid, is excluded by the layer of snow which covers the ice. "The appearance of the glaciers in winter is very impressive—all sounds are stilled; the cascades, which in summer fill the air with their music, are silent, hanging from the ledge of the rocks in fluted columns of ice." "There is no danger in entering the vault of the arveiron, for the ice seems as firm as marble."† Consequently, if, on Canon Moseley's theory, no motion can ensue during the summer, on account of the variability of the temperature of the ice, on Mr. Croll's theory, no motion can ensue during winter, because everything around the glacier, and its own

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* *L. E. & D., Phil. Mag.*, September, 1870.

† Tyndall's *Forms of Water*, pp. 89-92.

superficial layer of ice or snow, is at or below the freezing point.* All inward transmission of liquid pulses is impossible.

One point more may be touched upon. Perhaps the most puzzling of all glacial phenomena to those who have attempted to find a true and sufficient cause of the motion, is the behavior of the secondary and tertiary glaciers, and of those miniature névés and ice streams, which, from their triangular form, have been named by Agassiz, snow-trowels. This is directly opposed to what would naturally be expected, and to what every theory, Mr. Croll's included, requires. The Alpine glaciers were arranged by De Saussure in two orders: "Glaciers of the first rank are inclosed in valleys, which, though elevated, are commanded on all sides by hills." "Glaciers of the second rank are not confined to valleys, but are spread out on the slopes of the higher peaks."†

"To complete Saussure's description I will add, that glaciers of the first rank lie, in general, on very gentle slopes, varying from 3° to 10°, while glaciers of the second rank have a much steeper inclination, ranging from 15° to 50°, and even higher."‡

In the years 1844-5-6, careful measurements were made by Mr. Desor, to determine the rate of advance of these secondary glaciers. Several of the tributaries of the Aar were chosen for the purpose, and among them that of the Zinkenstock, whose slope varies from 30° to 50°. These measurements, which others have since confirmed, show, that while the Mer de Glace, with an inclination of 5° to 8°, advances at the maximum rate in summer of about 36 inches a day, this secondary stream, on a slope of 41° only, crawls down at an inch and a half during that interval.

At the same time the advance of the smaller masses (snow-trowels) was also determined, and found to be even less than that of the secondary streams, though lying on slopes of equal or greater inclination.

These facts, due to the care and perseverance of Agassiz and his companions, have proved great difficulties in the way of theories of glacier motion. If the glacier slid down, it should slide faster on a slope of 50° than on one of 5°; if it was thrust down by the expansion of freezing water, or crept down by dilitation, as Mosely supposed, the same result should follow. If it flowed by the force of gravitation, helped by an inherent viscosity, it must flow down a steep slope more rapidly than over a nearly level surface; and, finally, if it trickles down by steps infinitesimally small, during moments of liquefaction infinitesi-

* It is hardly necessary to point out how much more strongly this reasoning applies to the glaciers of the Polar region than to those of Switzerland, which are here directly alluded to. Yet, the constant formation of icebergs is satisfactory proof of their movement.

† *Voyages dans les Alpes.*

‡ Agassiz's *Systeme Glaciaire*, p. 3.

mally short, as Mr. Cròll supposes, it must in that case again obey the same rule and trickle further down a mountain side than along an almost horizontal valley.

Obvious consequences of the theory propounded by Mr. Croll, such as these, so directly opposed to all the phenomena of glacier motion, seem effectually to bar the way to its reception, even as a plausible theory. Some of Mr. Croll's papers upon geological subjects have been of great value, but we fear his attempts to read one of the greatest if not the greatest geological riddle of the present day has not been successful. Nor do we think the full solution of the problem is possible at present. Observations have not yet been sufficiently minute, continuous or extensive, even in classic Switzerland, to enable the cause of glacial movement to be detected. We do not yet know with certainty the most important element in the question. The late Mr. Wm. Hopkins deduced the swifter flow of the middle from the form and position of the marginal crevasses, though contrary to the opinion of Agassiz. But experiments have not yet proved whether the median current of the glacier is in a condition of compression from pressure behind or of tension from traction in front, or from both at different places. Possibly this might be determined by the polariscope, but its application is not easy, and no attempt has thus far been made in this direction. The secret seems to be rather in the mass of the ice glacier than in the other conditions. This was the conviction of Agassiz, when, in the conclusion of his great work on the "Glacial System of the Alps," published in 1847, he says: *

"The inclination of its bed is not the essential condition of the motion of a glacier."

"This motion is determined by its thickness rather than by its slope."

Mastodon Remains in Ohio.—By John H. Klippart.

In Ohio all the Post Tertiary formations are deposited upon the strata found in Ohio, between and including the Lower Silurian and Upper Carboniferous. Many geologists doubt whether coal in Ohio ever was formed west of the present boundary of this valuable mineral; or, what is the same thing, they doubt whether the Ohio coal-fields ever were continuous, and connected with those of Indiana and Michigan. In many places in Ohio, the western extremity of the lower

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* *Systeme* Glaciaire, p. 520.

coal vein is found to be "*feather-edged*," that is, the vein becomes thinner and thinner, until it disappears entirely, and the shales or sand rock overlying the vein are continued, until they rest directly upon the formation underlying the coal, thus demonstrating that the thinning out is not due to any mechanical process of attrition, such as glacial action, or erosion of any kind. And yet there is partial evidence at least, that the formations upon the immediate left bank of the Olentangy, at Delaware, were continuous to Logan county, notwithstanding that at the *present* time the Niagara is in isolated and limited localities the surface rock. If these deposits were continuous at any time in the world's history, then sedimentary deposits from 550 to 600 feet in height have been eroded, or removed between Logan and Delaware counties, the glacial action thus making an island of the eastern half of Logan county. The upper formation of Logan county—the Huron shale—is not found eastward from there until the left bank of the Olentangy is attained, in Morrow, Delaware and Franklin counties, and westward, or rather northwestward the outcrop is found at Defiance, Napoleon, and the south-west corner of Lucas county. At these latter points the shale formation dips to the north-west. At Delaware and Columbus it dips toward the south-east. Logan county may have been the crest of the arch of the anti-clinal axis passing through the State from Cincinnati to the islands in Lake Erie.

The almost level plateau found between the outcrop of the Huron shale in Central and Northern Ohio, and the State line of Indiana—most undoubtedly the result of glacial action; glacial striæ having been found near Lima, in Allen county, in Montgomery and Preble counties—for want of more perfect drainage necessarily abounded in swamps and morasses; and these were admirably adapted to the growth of aquatic plants, and their margins abounded with succulent herbage, and which afforded excellent pasturage for the mastodon and other herbivoræ.

Borings made in nearly a hundred of these swamps reveal a very remarkable uniformity in structure or formation. Bowlder clay, sand or gravel, or a mixture of all three, rests upon the rock *in situ;* then a stratum of clay, usually blue or black (if black, the color is usually derived from vegetable matter,—in a few instances this black clay has yielded the black oxide of manganese); over this stratum is found a stratum of peat or peaty-like substance; then a stratum of shell marl; then humus or vegetable mold, intermingled with sand and clay. With one or two exceptions only, either peat or a peaty-like substance and shell marl were found in every swamp in which borings were made.

As the greater portion of the western half of the State was covered with swamps and morasses, immediately after the glacial period or "great ice age," the vast amount of succulent herbage afforded by the semi-aqueous surface must have rendered Ohio somewhat of a mastodon paradise. In no other State have so many fossil, not petrified, remains of the mastodon been found as in Ohio, and it is perhaps no great exaggeration to state that in every twenty-acre swamp some remains of one of these gigantic mammalia may be found in western Ohio.

Nearly fifty years ago, the remains of one of these now extinct animals were exhumed in digging the canal, near the town of Massillon, in Stark county. I never saw this skeleton, but a gentleman who assisted in exhuming it told me that the tusks measured more than 11 feet in length, and were fully 8 inches in diameter at the base. About the same time, the tusks, vertebræ, and some other portions of a skeleton were taken out of a marl pit in Medina county—the tusks were 12 feet long. About forty years ago, a complete skeleton was exhumed in Crawford county, and, if I have been correctly informed, the same skeleton is now in the British Museum. A few years since, a nearly complete skeleton was dug up in the immediate vicinity of Cleveland, but was destroyed on the spot by the workmen, who broke all the bones into fine pieces. Near Sandusky, a tusk of one was exhumed; a portion of this tusk is now in the museum of the Homeopathic College, in Cleveland. At Fort McArthur, in Hardin county, a considerable portion of a skeleton was exhumed. These remains were evidently drifted out of the Scioto marsh, they being found scattered over a considerable area. In 1869, whilst ditching in his meadow, W. A. Howard, of Woodstock, Champaign county, dug up a femur in a most excellent state of preservation, together with small ribs and bones of the feet as well preserved. This femur was for several years on exhibition in the State Agricultural Rooms, in Columbus. In 1870, in digging a township ditch in Clay township, Augusta county, near the village of St. Johns, an entire skeleton was found standing upright, but sunk down in the surrounding muck, so that the vertebræ were several feet below the surface. The skeleton was complete when found, but the tusks, spine, cranium, and some other portions, were so completely decayed that they crumbled when the attempt was made to remove them. The lower jaws, teeth of the upper jaw, radius, ulna, humerus, tibia, fibula and femur, bones of the feet and some of the ribs, were in a sufficiently good state of preservation to be removed. A portion of these remains are in the High School building, at Wapakonetta. A tusk and some bones were reported to have been found near Greenville, in Darke county, but I was never able to obtain any details or specific information in relation to them, yet have no reason to discredit the report. In 1871, a considerable portion of a skeleton was exhumed in Clark county, and the remains removed to Wittenberg College, at Springfield. Some years ago an account was published in the *Dayton J. unal* of the finding of a tusk, teeth, and some other portions of a skeleton, near Germantown, in Montgomery county. Portions of a skeleton were discovered in a swamp or bog, near New Holland, in Fayette county, but have not yet been removed. The upper jaw, together with a considerable portion of a cranium, were found several years since in Pike county. These remains were on exhibition for several years in the State Agricultural Rooms, and were owned by a Mr. Faust, of Galion or Crestline. I have recently been advised, that near the junction of Franklin and Pickaway counties with Madison, a skeleton has been discovered, and am requested to name a day when I can be present to direct the removal of it.

The remains found at Massillon were the only ones found within the coal basin in Ohio, and even these were on the edge or margin, rather than in the basin.

All of these mastodon remains just enumerated were found imbedded in swamps, morasses or bogs; and it is fair to presume that as the lowlands in the north-western part of the State become drained, cleared and cultivated, many more skeletons, not only of this now extinct mammal, but many others in addition to it may reasonably be expected to be found and exhumed. In digging the Ohio canal, in the vicinity of Nashport, Muskingum county, the right lower jaw of *Castor Ohioensis* (now the property of Mr. Van Vorhies, of Nashport), was found some twenty-five feet from the surface, embedded in a "muck," as Mr. Van Vorhies informs me. Within the corporate limits of the city of Columbus, and near the junction of the Olentangy with the Scioto river, the skeletons of twelve *Dicotyles* (*Platygonus*) *compressus* were discovered. These last were described by me in a paper read at the last meeting of the American Association for the Advancement of Science, and published in the last January number of this *Journal.* In excavating for the foundation of an exterior wall, at the Ohio Penitentiary, the warden (Mr. Burr), found the fossil jaw of a horse, with the molars in good condition. If the teeth and jaw held the same relative proportion to the body as do those of the existing horse, then the fossil horse must have been fully one third larger than the ordinary horse of to-day. The foregoing is a complete enumeration of all the fossil post glacial mammalia which, to the best of my knowledge, have been found within the limits of this State. There is no doubt that Ohio is rich in the remains of post glacial fauna, which properly organized and directed efforts only can discover and secure. There is no good reason to suppose that the same species of animals whose remains are so very abundant in some of the western territories did not once inhabit Ohio, and roam over the wide-spread prairies, once such a marked feature of Ohio's landscapes.

Until within the last few years no effort has been made to preserve these remains; and the discovery of all of them was purely accidental. Cave explorations have been conducted in England by scientific associations with the happiest results. The British Association has expended over $5,000 in "digging" in "*Kent's Cave*," in Devonshire. In 1874, it expended $1,000 in cave explorations alone; an aggregate sum of $8,000 was appropriated for scientific investigations during the year 1874. Why can not Ohio associations accomplish something like that which the British Association is annually doing?

Notice of the Chemical and Geological Essays of T. Sterry Hunt, and of the words Cambrian and Silurian.

Mr. Hunt has republished, in book form, various memoirs, which he regards as possessing peculiar scientific and historic value, under the title of "Chemical and Geological Essays." He seems to be under the impression that his scientific work has not been duly appreciated, and reminds the reader so frequently of his original discoveries, that one is almost led to believe that a mistake was made in the title of the work, which might more appropriately have been, "Mr. Hunt's own eulogy of himself and his labors."

Had he been contented, however, with expressions of his own views regarding himself and his discoveries, and not attributed to other persons views they never entertained, his work would have been more fortunate, and he would have saved himself from some severe criticisms.

Mr. James D. Dana (*Am. Jour. of Sci. and Arts*, Feb., 1875,) has reviewed the work so far as it attributes to him opinions that he never expressed, and charged Mr. Hunt with a long list of inexcusable misrepresentations. We will quote one paragraph from Mr. Dana's review:

"*I have never held, and my writings nowhere sustain, the following opinions which Mr. Hunt has attributed to me and others:*

1. The possibility of converting almost any silicate into any other.

2. The possibility of converting granite into limestone.
3. The possibility of converting gneiss into limestone.
4. The possibility of converting diorite into limestone.
5. The possibility of converting granite into serpentine.
6. The possibility of converting granulite into serpentine.
7. The possibility of converting gneiss into serpentine.
8. The possibility of converting diorite into serpentine.
9. The possibility of converting limestone into granite.
10. The possibility of converting limestone into gneiss."

But the self-sufficiency of the author, and the misrepresentation of the personal views of other individuals, are by no means the only serious objections to the publication. Chapter xv., on the "History of the names Cambrian and Silurian in Geology," is an essay pretending to give the history of these two words, the use that should now be made of them, and the proper credit that should be extended to the authors; but it omits to mention many of the leading events in the history of the origin of the term Silurian, magnifies, if it does not invent, trifling incidents in the origin of the term Cambrian, and finally advocates the substitution of the word Cambrian for Lower Silurian in American geology, without any good reason and in violation of the established laws of nomenclature. The word Silurian has priority over that of Cambrian. It was applied to the rocks after their fossil contents had been studied, and after they had been divided into groups, while Cambrian was applied to a series of rocks without any knowledge of their fossil contents. The terms, Upper Silurian and Lower Silurian have been in general use since 1835, in every country where geology has been pursued as a science, while Cambrian has only been applied since 1836, locally in Great Britain, to rocks that have long since been known to constitute part of the Lower Silurian series. A few of the leading facts connected with the history of the terms Upper and Lower Silurian (nearly all of which Mr. Hunt has omitted from his essay) are as follows:

On the 17th of April, 1833, Murchison finished the reading of his memoir, commenced at the preceding meeting (March 27, 1833), before the Geological Society of London, "On the Sedimentary Deposits which occupy the western parts of Shropshire and Herefordshire, and are prolonged from N. E. to S. W., through Radnor, Brecknock, and Cærmarthenshires, with descriptions of the accompanying rocks of intrusive or igneous characters." He separated the rocks, commencing at the base of the old red sandstone, in descending order, as they succeed each other in Shropshire and Herefordshire, into six formations, founded upon their fossil remains and order of superposition, as follows: First—*Upper Ludlow rock* (so named because the Castle of Ludlow stands upon it), having a thickness of about 1,000 feet, very fossiliferous, and characterized by *Strophomena*, *Orthoceratites*, trilobites of the genera *Homalonotus*, *Calymene*, etc. Second—*Wenlock limestone*, about 100 feet in thickness, and characterized by the abundance of its corals, encrinites and mollusca. Third—*Lower Ludlow rock*, about 2,000 feet in thickness, and characterized by its *Orthoceratites*, *Lituites*, *Asaphus caudatus*, *Pentamerus lævis*, etc. Fourth—*Shelly sandstones*, from 1,500 to 1,800 feet in thickness, and characterized by its *Leptenæ*, *Spiriferi*, crinoidal remains, etc. Fifth—*Black trilobite flagstone*, exceeding 2,000 feet in thickness, and characterized by the *Asaphus* (*Ogygia*) *Buchii* and other trilobites. And sixth—*Red conglomerate sandstone and slaty schist*, several thousand feet in thickness, in which no organic remains had then been observed.

He regarded the deposits four, five and six, as three separate formations, entirely differing from each other and from the Ludlow formation, in their characters mineral and fossil, and in the distinctness of their physical demarkations.

On the 22d day of January, 1834, Mr. Murchison read another memoir upon the same subject. After having devoted another summer to the study of the organic remains and order of superposition of the rocks, he divided them into five formations as follows: First—*Ludlow rocks*, 2,000 feet in thickness; second—*Wenlock and Dudley rocks*, 1,800 feet in thickness; third—*Horderly and May Hill rocks*, 2,500 feet in thickness (this was made the equivalent of subdivision four in his memoir of March 27, 1833); fourth—*Builth and Llandeilo flags*, 1,200 feet in thickness; and fifth—*Longmynd and Gwastaden rocks*, many thousand feet in thickness. This year he accompanied his memoir with a map, showing the order of superposition and the fossils so far as they had been ascertained belonging to each of his subdivisions, and it may be added that those most characteristic were then known and mentioned by him.

Subsequent study of the fossil contents of these several subdivisions led Mr. Murchison to the conclusion that they were parts of one great formation, and in honor of the ancient tribe of Silures he proposed for the formation the name Silurian, which he published in July, 1835. He divided the formation into Upper Silurian and Lower Silurian rocks. The first three groups, as named in his memoir of March 27, 1833, he placed in the Upper Silurian, and the fourth, fifth, and sixth, in the Lower Silurian.

The President of the Geological Society of London, Mr. George B.

Greenough, in his anniversary address to the Society, on the 21st day of February, 1834, said:

Mr. Murchison has employed three summers in examining a range of country situate between Shrewsbury and Cærmarthen; and the geological positions, as well as the mineral and zoological characters of the several rocks which border England and Wales, are now determined with as much exactness as those of any portion of the secondary system. Taking the old red sandstone as a line of departure, the rocks beneath are disposed in descending order, as follows:

1. The Ludlow series, divisible into three parts—the upper, middle, and lower. To the middle belong the well known limestone of Amestry and Ledgley; the upper and lower consist of sand, marl, or flagstone, having some fossils peculiar to each, and others in common. The thickness of the whole is estimated at 1,000 feet.

2. The Dudley or Wenlock series consisting of limestone; its thickness may be taken at 2,000 feet.

3. The Horderly or May Hill series, composed of party-colored sandstone, conglomerate and impure calcareous flagstone; it is said to attain a thickness of 2,500 feet.

4. The Builth or Llandeilo series, a black flagstone, characterized by the *Asaphus Buchii.*

5. The Longmynd or Linley series, consisting of coarse roof slates, sandstone and conglomerate; no fossils have been discovered in it.

It is well known that Prof. Sedgwick has studied with equal assiduity the rocks which lie beneath those I have mentioned. When his observations are published, the Society will have a type of the whole of the transition rocks of Wales. The rocks described by Mr. Murchison are for the most part exceedingly well characterized by their fossil contents. Some of the shells which he has discovered appear to have escaped the notice of antecedent observers; but the genera, if not the species, of others may occasionally be found in the works of Hisinger and other continental writers. If, then, the transition as well as the secondary and tertiary beds can be identified over great tracts of country by their fossil remains, let us hope that a clue is now at hand by which we may find our way through that vast assemblage of beds, which, not in England only, but in Scotland, Ireland, Germany, Russia, Sweden and North America, has hitherto presented to the observer a mere scene of confusion."

On the 19th day of February, 1836, Mr. Charles Lyell, President of the same society, in his anniversary address, said:

"It is with pleasure that I next call your attention to the investigations which Mr. Murchison has been steadily pursuing in the older fossiliferous rocks of Wales and the bordering counties of England. He has at length brought his survey of five years to a successful termination; and his work will form a most important step in the progress of geological science, not merely as elucidating the history of a portion of the sedimentary formations of our island, but as fixing the characters of a succession of normal groups, to which the strata of other parts of Europe, and perhaps of America, may be referred. A large, and beautifully illustrated treatise, in which he intends to give a detailed description of his original observations and views, will soon be published. In the meantime, we have tasted, as it were, by anticipation, the fruits of his labors, having, year after year, received at our meetings the earliest intelligence of his discoveries, and having freely discussed and criticised them long before it was possible for him to lay the whole in a matured and digested form before the public. You are aware that the system of rocks, which have been the chief object of his research, constitutes the upper part of what was formerly called the transition or greywacke series. In these strata, which had previously remained in a state of obscurity and confusion, he has distinguished several formations. The old red sandstone rests conformably on the uppermost of these, while the lowest of them repose both conformably and unconformably on the ancient slate-rocks of Wales. Mr. Murchison proposes the general name of "Silurian" for this whole system, as the strata studied in those parts of England and Wales once occupied by the ancient British nation, the Silures.

The necesssity of a new term has arisen from the uncertain latitude with which the word "transition" had been applied—some authors including in it the carboniferous rocks; and also, from the still greater confusion introduced by the word "greywacke," a term which can only be employed conveniently in a mineralogical sense, to designate a peculiar kind of rock which has been formed at many successive epochs. Thus, for example, in the memoir now under review, it is shown that in Pembrokeshire, grits, which have passed for greywacke, occur in the true coal-measures in the old red sandstone in the Silurian, and in the still older systems of rock.

Below the Silurian strata are slate rocks of older date, in which traces of organic remains have been again detected; and Prof. Sedgwick, has suggested the name of Cambrian for this more ancient system, which is conterminous over a wide territory with the Silurian formations, the relative position of both being clearly seen.

Mr. Murchison has recently traced the Silurian system running in zones through Pembrokeshire, and there rising out in the coast cliffs from beneath the old red sandstone as conformably as in the interior of the country—an important verification of the accuracy of his previous determinations. Great lithological changes are, however, observed to take place in these localities, so distant from the best types of the system; thus, the "Ludlow and Wenlock" formations are no longer distinctly separated by subordinate limestone, and are therefore simply termed the "Upper Silurian" rocks, and these, changing their soft argillaceous characters of "mudstone," become hard sandstones, yet contain some well known organic remains; whilst the "Lower Silurian" rocks, or Caradoc and Llandeilo formations, not only maintain their usual fossil distinctions, but exhibit limestones of much greater thickness than in any other part of their course.

In brief, Mr. Murchison studied the rocks in England and Wales, that repose beneath the Devonian, and from their fossil contents separated them into groups, in the years 1831 and 1832, and published his labors in that behalf in the spring of 1833. He continued his study and labors through that year, and determined that the three groups, which he had found next below the Devonian, were more intimately connected together by their zoological remains than they were with the next lower groups, which were likewise connected together in the same manner. He here laid the foundation for the division into upper and lower groups. He not only realized the importance to science of his great discoveries, but his contemporaries likewise saw that his study of the organic remains had made it probable, that his groups would be found extending over a great part of Europe, and, possibly, determinable even in America. In 1835, in the fifth year of his special labors on this formation, he applied to the whole of the groups the name Silurian, and called the three upper groups the Upper Silurian, and the remainder the Lower Silurian. Subsequently, paleontologists found that his discoveries were world-wide in their application. Fossils, that he described as characterizing the Upper Silurian and Lower Silurian, were found, or their equivalents, in Germany, Bohemia, Canada and the United States, occupying the same relative position in the rocky strata of the earth. His triumph was now complete. He had brought order out of confusion, and determined the relative position of miles of strata of the earth, founded upon the fossil contents which had been hitherto unknown.

In 1836, Mr. Sedgwick, the Cambridge professor, proposed the name Cambrian, for a series of rocks, the mineralogy of which he had been studying, and which he supposed to underlie the Lower Silurian. But when the fossils came to be studied and described, they were found to be Lower Silurian forms, and the strata merely an extension of the rocks described as Lower Silurian by Mr. Murchison.

The word Cambrian, therefore, so far as it has been attempted to apply it to a geological formation, is a synonym for part of the Lower Silurian. It has not, however, been used in the geological nomenclature of America, for which we may thank the paleontologists connected with the State and Government surveys, nor is there any likelihood that it will ever come into use, either as a substitute for Silurian or in a word compounded with it.

Rambles of a Naturalist in Southern Florida. By W. W. Calkins.

The "Land of Flowers," where Ponce de Leon sought for the "fountain of perpetual youth," first dawned upon my vision from the deck of a steamer off Cedar Keys, where we arrived January 23d, after a stormy voyage from New Orleans of five hundred miles. We were on this beautiful morning suddenly made aware of our entrance into more genial climes than those of the frozen north, or damp and foggy Louisiana. While we lay at anchor, seven miles from the shore, I made my first essay at collecting shells, in five fathoms of water. For the purpose, I used a small, light dredge, that at home I had fixed up with a wooden handle, but now I substituted a small rope. My success was beyond my expectations, and embraced the following species: *Marginella apicina*, Chem. *gracilis*, Cerith. *nigrum*, *Dentalium entalis*, a few crustacea and star-fish. Having exchanged mails, we left Cedar Keys and steered southward. The sea was as quiet as a mill-pond the rest of the way to Key West. We saw numerous *Physalia* with their purple blue barques floating on the waves, and captured specimens of the gulf-weed (*Sargasso baccifera*), on this we found crustaceans and shrimps that are peculiar to the gulf-weed. The auguries were propitious, the weather fine. The heavens and earth seemed to blend as one, resting on the calm, blue sea. We forgot our own dear, frozen North, and reveled in dreams of eternal summer, and things too impossible to be real. But this is the nectar—the sentiment that makes life sweet, cheers the heart, and fills us with new and noble ambitions. Well, we steamed on past Tampa, that rich ground for collectors, and the *Espiritu Santo* of De Soto, who arrived there in 1539. Reaching Key West on the twenty-fifth parallel, we began to realize that old things are passed away. I surveyed with some interest the people—a heterogenous mass of Americans, Africans, Spaniards, *et cetera*—dressed in linen or cotton, and many carrying umbrellas—for my friends must remember that the thermometer stands from eighty to ninety degrees above in the shade. Of greater moment to me, however, were the fruits exposed at every corner; here were oranges, lemons, bananas, shaddocks, bread-fruit, sapodillas, and their cheapness was quite as astonishing as their novelty and richness. The *Flora* of this island is West Indian and tropical. The Key, six miles long and one wide, affords a number of indigenous species also; but in the whole country no one can be found who has worked up its botany. I noticed several varieties of cactus. The *Cactaceæ* and *Palmaceæ* are common. I saw, growing wild, flowers that bore a remarkable resemblance to some at home, preserved with tender care in greenhouses. Scattered through the island are date and cocoa-nut palms. The *Fauna* is rich, but not numerous in species. Rambling down the beach, I was rewarded by finding such forms as *Nerita peloronta*, *N. scabricosta*, *Lit. scabra*, Cerith. *nigrum*, and stranded by the recent blow, were the *Ianthina fragilis*, *Physalia*, *Dosinia discus*, *Lucina tigerina* and others. The small hermit crab (*Eupagurus longicarpus*) are abundant in the Cerithiums and Littorinas, while the larger species (*E. pollicaris*), appropriate larger shells for their dwellings, such as *Fasc. distans*, *Trocus*, etc. Walking along the shore, the ear is greeted by a peculiar, rattling noise, which is caused by the fiddle crab (*Gelasimus pugilator*). This variety exists in thousands, and occupy little holes in the sand. If caught outside by an enemy, they instantly retreat, taking good care to keep their houses uppermost. It is truly a comical sight to witness their movements. The posterior part of the body is perfectly soft and naked, and finding an empty shell suited to their purpose, they never abandon it until they find a better shell. The horse-shoe crab (*Limulus polyphemus*) may be found in from one to two feet of water. Occasionally I found a stray sea-urchin (*Echinus*). Beautiful *Algæ* float upon the beach. Part of the Key is uncultivated and being overgrown with mangroves, cactus, etc., affords a good retreat for land shells. The following are abundant: *H. cereolus*, *H. orbiculata*, *Cylindrella Jejuna*, *Chondropoma dentata;* in less numbers I found *Macroceramus Kinieri*, and *Bulimas undatus*. Near some brackish ponds my efforts were rewarded by specimens of *Tralia Floridana*, *Tralia cingulata*, and *Cerithidea*. Having worked up the species here, including *Truncatella bilabiata*, which are very abundant, myself and party sailed in an eight-ton schooner for the Marquesas and Tortugas. At the first named place, we obtained the following shells, *Melongena corona*, *Melampus coffea*, *L. scabra*, *Arca Americana*, *Mytilus hamatus*, *Fasc. distans*, *F. tulipa*, and *F. gigantea*, *Pyrula perversa*, *Strombus* *gigas*, *Pyrula carica*, besides *Cardiums*, *Dosinias*, and other common forms. Fish and birds abound; among the former, sharks, sting-rays and saw-fish are the most noticeable. We captured one of the latter, thirteen feet long. Shark harpooning afforded us much amusement. One big fellow carried off in his body two of our harpoons, having first bitten off a piece of the gunwale of the "dingy" in which we were, and by a sudden flank movement, precipitated five of us into the bottom of the boat. Besides herons and gulls, we saw plenty of fish-crows (*Corvus ossifragus*), and a large blackbird (*Quiscalus baritus*). The Keys are overgrown with mangroves, making it almost impossible to get through them. I found no land shells here.

After we had secured a number of specimens, we sailed for the Dry Tortugas, about forty miles out in the gulf. We went down in a norther, making it somewhat unpleasant, as the waves rolled high and fearfully. However, our little vessel rode like a duck, and, at last, finding ourselves at anchor under the walls of Fort Jefferson, we began to feel, indeed, as though we were out of the world. Seven small, sandy keys, almost destitute of vegetation, constitute this famous place—the Dry Tortugas. Millions of money have been wasted here on the fort and armament. Fort Jefferson, built of brick, on improper foundations, and mounted with several hundred heavy guns, is gradually cracking its walls and sinking in places. It is nearly a mile in circumference, and surrounded by a deep moat, with which the sea communicates. On the walls of this moat I found several species of mollusks and coral. But the great attraction of the Tortugas are the great coral reefs now growing around the harbor and outside. The grandest sight that I ever witnessed, was afforded by looking down into one of these living forests through a water-glass. Here were the varieties known as *brain*, *star*, and *finger* coral. The latter grows like a tree, spreading out into innumerable branches, through which may be seen gliding brilliant-hued fish and mollusks. Waving *Gorgonias* intermingle. The sun, shining down on the blue sea, lends a reflected and beautiful radiance. One can easily imagine himself in some fairy palace, built by unseen hands, and inhabited by fairy forms. Transported with delight, I had, however, *one* regret, namely, that more of my friends were not there to share the enjoyment. The corals that I saw were in from ten to fifteen feet of water, and embrace a number of species. We obtained a large amount by means of hooks. I brought up on the roots of a piece a fine *Octopus rugosus*, or cuttle-fish, that measured across the arms over three feet. This is allied to the huge cuttle that we read of. Its power is in its cup-like suckers, with which it adheres to its prey or hiding-place. By the free use of alcohol I managed to transfer the specimen to a collecting jar, and I hope to be able to show it to my friends when I get home. To obtain shells here, one must dredge. I obtained the following species: *Porc. exanthema*, *Ovulum gibbosa*, *Arca Noæ*, *Turbinella*, *Turbo*, *Marg. fimbriata*, *Chama macrophilla*, *Strombus gigas*, *St. bituberculatus*, *Trocus spinosa*, a *Lithodomus*. *Teredo navalis*, etc. *Echinus* of two or three species are common in four feet of water. Lobsters, two feet long, and huge green turtles, are to be found, as well as plenty of sharks and other fish. Altogether, Tortugas is a good field for the naturalist, if he goes there armed with proper collecting apparatus, and does not mind the abandoned and lonesome appearance of everything. A tremendous north east storm prevailing while I was there, hastened my departure; but I did not leave without some satisfaction, in having seen this extremity of Uncle Sam's dominions.

The Use of Mica Plates by the Mound-Builders—The Age of their Mounds.

By S. S. Scoville, M. D.

About fifteen years ago, an ancient mound, situated upon the East Fork of the Little Miami, twenty five miles east of Cincinnati, was opened. At the base of the mound, or on a level with the surrounding ground, were found human bones in number and character sufficient to show that at least half a dozen bodies had been deposited here. The remains were so poorly preserved that scarcely an entire bone could be found, yet the outlines of an entire skeleton could be traced. Several of the bodies, if not all, had been placed with their heads together, or but slightly separated. This was shown by the cranial bones, a few of which were nearly entire, though disposed to crumble immediately upon being removed from the earth. The bodies evidently had been placed upon the back. Lying upon, or immediately over the cranial debris, were found plates of mica, some a foot in diameter. These plates were disposed in such a way as to cover an area somewhat larger than that occupied by the crania beneath. However, it could not definitely be determined whether the design had been to make a continuous or common roof over the faces as a group, or whether each face had a covering of its own. The plates were generally separated by a few inches. They may originally have been much wider and overlapped, as their edges were very fragile and disposed to crumble.

The above statement is not made from personal knowledge, but was communicated to the writer a few days subsequent to the discoveries, by an intelligent gentleman who conducted the exploration. He presented me with several pieces of the mica, most beautiful specimens as regards transparency.

The fact of mica being interred with the remains of the Mound-Builders is, of course, not new, but for what purpose I had never ventured even a conjecture. From this, and numerous other discoveries, I am inclined to the opinion that mica was used by this ancient people to exhibit the features of the dead, in the manner that glass is now used by the more enlightened nations of the earth. Whether the body at death was put in some kind of casket with the mica placed over the face, and in this condition seen by the friends for the last time, or whether it was placed in a vault in the mound where the relatives could enter, and through these transparent plates look upon the departed, may never be determined. There is some evidence, to which we may briefly allude, favoring the idea that these burial mounds, at least some of them, were real vaults or sepulchers.

There is another theory as to the use of mica, and which might be rendered plausible, if it could be shown that the religious ideas of this people were similar to those of some of our Indian nations, that is, that these transparent plates, being placed over the face, assisted the deceased to see his way as he journeyed to the far off country, or "happy hunting ground." To say the least, this peculiar mineral, to them, undoubtedly possessed wonderful virtues of some kind.

To what extent mounds have been found containing chambers, we are not advised; we know, however, that they do exist. With the smaller mounds we should not expect to find the rooms remaining. Any door-way to the interior would also be obliterated. It might be urged, that if these mounds were once hollow, depressions, caused by the earth sinking from above, would be noticeable. Such depressions may have once existed, but the ceaseless wear of centuries, it may be, since the sinking in, has rounded off the exterior, and we have, as is often witnessed, a circular mass of earth, say thirty feet in diameter, with a height of no more than three or four feet.

In opening a mound, it not unfrequently occurs that near the base and center the earth becomes quite loose, and in some cases dark streaks of vegetable mould are seen, caused, as I believe, by decayed wood, possibly the roots of trees. In the few cases which have come under my own observation, the streaks were too straight and uniform in their course for decayed roots. The idea suggested was, that the mounds had contained rooms, and these dark streaks resulted from the decay of timbers which supported their roofs. These streaks or discoloration of the earth, seen by myself, occurred in mounds of small size, and in which no human remains were found.

The placing of bodies in a vault, such as we have suggested, might account for the poor state of preservation in which skeletons are found. If the remains were placed upon the ground, and compact earth thrown directly on them, and piled to the height, say, of fifteen feet, the date of burial must indeed be remote to account for the decay generally witnessed, especially when we consider that many of these mounds occupy natural rounded-off elevations favorable to the preservation of whatever they may have contained.

We can not, however, consent to the great antiquity which some have given to these monuments. In the last number of the CINCINNATI JOURNAL OF SCIENCE, Prof. R. D. Smith speaks of "*three feet and a half*" of soil which was passed through in making an excavation in the top of a mound, and which had, as he supposes, accumulated since its construction. He suggests that this circumstance might furnish a clue to its age. The top of the mound being level, and large enough to be cultivated as a garden, was certainly favorable for the accumulation of soil. But was it quite clear that a depression did not at one time exist at the center, or place of making the excavation? Any old depression or excavation would have been filled up by tillage, if from no other cause. After describing the pot-like hole, which, it was thought, marked the original height of the mound, the Professor says: "The excavation was continued to the level of the surrounding country, but without further results." Now, if his conclusion is correct, that three feet and a half of soil had formed on the top of the mound since it was built, then, evidently, the excavation lacked at least this distance of reaching the original base; for surely the soil upon the surrounding ground, or "surrounding country," would accumulate as rapidly as it would upon the top of the mound.

My observations, which, I confess, have been quite limited, go to show that the original bases of these mounds are found to be but a trifle below the surrounding ground. In the case of the one described at the commencement of this article, no actual measurement, it is presumed, was made; but the base of the mound, where the skeletons were found, was mentioned as being on a level with the ground adjacent. In the case of two mounds of small size, and which were situated on quite level ground, I could, by the eye, perceive but a slight difference; their bases could not have been but a few inches below the surrounding ground. Trenches were dug from the circumference to the center, their bottoms following the top of the original soil. Cuts through the old earth-works show that there has been but a slight accumulation of soil upon the adjacent ground since the embankments were constructed. This can readily be verified at Fort Ancient, on the Little Miami river, where numerous breaks in the earth walls abound.

There is but little doubt that some of these mounds and earth-works, found in Ohio, antedate others by at least several centuries. Evidence of this is found in the fact, that in some instances the accompanying excavations are completely filled up, or obliterated; besides, the mounds or embankments are much more worn or flattened.

I am inclined to think that a critical examination of the old excavations in the vicinity of these *tumuli*, or fortifications, would afford at least an approximation to their age. A fine opportunity is offered for such investigations at the fortification, on the Little Miami, just referred to. I have myself made limited observations in this direction, not, however, at this place. The original depth of the excavations can generally be readily ascertained. I have made some calculations in the case of two or three of these old diggings, which were examined as to the time required to produce the depth of loamy soil found in them. To give, however, expression to any opinion I may have formed from observations so limited, would be, to say the least, quite premature. It is to be hoped that a more careful and extended research, touching the age of these ancient works, will be made. Even an approximation to the date of these "olden times" might shed much light upon numerous questions now engaging the attention of the scientific mind.

A few words more as it regards the use of mica. So far as my knowledge extends, the plates are generally found as if designed to cover the face. In a few instances, one of which is given by Prof. Smith in his communications referred to, they are found placed over the hands as well as face. The exhibition of some ornaments, or trophies worn upon the wrists, may have been intended in these cases. In the case of the celebrated skeleton, found in a mound on the Scioto river, four miles below Chillicothe, a history of which is given by Squire, the cranium, which was well preserved, was lying upon its face, with the mica placed over the back part of the head. Some are of the opinion that this person represents the Toltecan race.

There is much in connection with this case which goes to show that the remains had had a previous interment, and that the bones, but not all of them, for some were missing, had been removed to this place. The inferior maxillary and other bones were absent; those remaining had been piled around the head. Now, if our surmises are correct, that nothing but this partial skeleton was deposited here, the friends would have paid less regard to prevailing customs in its burial. This same plate of mica may have previously covered the face of this individual as he lay, it may be, in state. That these remains belonged to a person of distinction, is highly probable.

We would not be understood as conveying the idea that mica was used by these people for no other purpose than that which we have indicated, or that its presence in mounds can, in any way, always be accounted for. It is sometimes found without any discoverable relation to relics of any kind. That it was used for windows to their houses is quite probable. And were we to suppose that these mounds, some of them, at least, were occupied as winter abodes, or as places for storing away provisions, it might justly be inferred that windows of this material were constructed for admitting light.

Origin of Flint. By C. S. S. Griffing.

[Read before the Columbus Natural History Society, February 27, 1875.]

In the summer of 1870, in company with your vice-president, Hon. J. H. Klippart, I visited Flint Ridge, in Licking county, and found beds of buhr-stone, a cellular, siliceous, flinty rock, from which, in the early settlement of this State, mill-stones of good quality were manufactured.

We also found beds of flint, massive, compact silica, very hard and tenaceous, where it had not been exposed above the surface; but where it had been thus exposed, often readily broken into small fragments with a blow from a hammer. In some places, acres of the surface were covered with broken fragments of flint spawls, where a pre-historic race had evidently manufactured arrowheads. In many places, depressions of the surface show where excavations have been made, to reach the unexposed stratum below the friable influence of atmospheric action, from which, evidently, the best implements of the stone age found in this vicinity were made. Since the time mentioned, I have repeatedly visited this formation, and learned that there are two layers of flint, that spread nearly or entirely over the same extent of territory. The first, or lowest, is about one foot in thickness, and above the second seam of coal in our Ohio series; the second, some two hundred feet higher, and about four feet in thickness, where I have observed it, but it is reported to be much thicker in some other places. In both layers I have found the common carboniferous fossils of that horizon, sometimes the form filled with finely crystallized quartz, but generally taking the ordinary siliceous texture of the flint.

I have observed that this formation extends from the southern part of Knox county south for more than an hundred miles, and where borings have been made for salt or oil, it is found to maintain a generally uniform thickness of four feet. From west to south, I have traced it on the surface about thirty miles. The dip, south and east, conforms to the ordinary strata of rock and coal.

How far this formation extends in either direction, beyond where I have traced it, I do not know, and only know that here is an extended field of siliceous matter, which was in some way deposited of nearly uniform thickness, and encasing numerous specimens of carboniferous fossils, with seams of coal laying above and below it. Below this main stratum of flint is iron ore, and fossiliferous limestone, and lower still, in parts of Licking and Muskingum counties, a white sand rock, locally called glass stone, that has for a long time been used for making glass in Zanesville.

The ordinary theory for the origin of such siliceous deposts, I believe, has been thermal springs, or the shields of diatomaceæ. But no indications of conical formations existing here, giving evidence of having been vents through which heated siliceous waters have flown, such as are always found where this phenomenon has existed, and the absence of any appearance of disturbance in the underlying strata, I think, forbids the acceptance of the thermal spring theory, and requires us to attribute to some other cause the appearance attributed to a high temperature present when it originated.

The other theory is, that flint is made up of the microscopic, siliceous shields of the diatoms, which are generally regarded as plants, although Ehrenberg refers them to animalcules. These diatoms, Dana says, grow so abundantly in some seas, that they are now producing large, siliceous accumulations. Professor Newbery, in a recent series of notes on the history of plant life on the globe, contrasts the abundance of diatoms during and since the tertiary period with their previous rarity, and suggests as an explanation, the ready solubility of the silica of diatom shields, and thinks "the early diatomaceous beds may have been destroyed and obscured from this cause, and the large amount of siliceous matter which appears in sedimentary rocks, as chert, buhr-stone, silico-calcareous beds, etc., in the Western States especially, may be largely of diatomaceous origin; and the material being plainly indigenous in the deposits, there are no such evidences as would allow, in the cases referred to, of the explanation of thermal spring action." Although the flint of which we speak is of carboniferous formation, its origin is probably to be attributed to the same cause as that of succeeding beds, whatever that may have been.

A British government-vessel, the Challenger, is now engaged in circumnavigating the globe, on a scientific exploring expedition, investigating the bottom of the sea at different depths. Last autumn, some importants reports of discoveries were made, and within the last month Professor Huxley has delivered a lecture in London upon these discoveries, and their bearing upon some important problems in geology. In reviewing the knowledge that existed on this subject, previous to the expedition of the Challenger, he says, the world is indebted for it chiefly to the researches of American ships; that the Americans had submitted the greenish mud they had taken from the bottom of the Northern Sea, at 14,000 feet deep, to Ehrenberg, who had for sixteen years been maintaining the paradox, that chalk was made up of the shells of minute animalculæ, and from this American collection he had been enabled to confirm his theory; that there was found, not only vast quantities of calcareous matter, but a still larger quantity of siliceous matter; that the Arctic and Antarctic waters are covered with a scum of vast extent, and this scum, under microscopic examination, is found to be made up of two or three species of minute animals, chiefly *Radularia*, *Globutomaria* and *Foraminifera*, and the lowest conceivable plant, a diatomaceous thing, consisting only of a protoplasmic shell. The shells of these minute things, the beginnings of organization on the globe, are found to have made the mud of the bottom of the seas referred to. It is a grayish mud, tinged with green, and so light, that the plummet was found to have sunk three feet into it, almost as if it had been water. This mud, under the microscope, was found to be entirely shoals of shells, and the beautiful snow-white forms which they individually represent are distinctly shown.

Between Teneriffe and St. Thomas, the Challenger found two deep valleys at the bottom of the sea, from which it drew up red mud from a great depth. This mud showed no shells at all, but Dr. Thompson, the chemist on the ship, found that, though the shells were absent, the chemical ingredients of the mud, which was simple clay, were the same as the mud taken at less depths. Thus, it was proved that the red clay was the ashes of the plants and animals which had been dissolved at that great depth. In the opinion of Dr. Thompson, this was due to the fact, as shown by observation, that the deeper strata are very rich in carbonic acid, this, forming more than one third of the gaseous component of the water. This composition, together with the very great pressure exercised, causes a rapid solution of carbonate of lime, leaving only the other constituents. Therefore, what Ehrenberg proved of chalk, may now be regarded as true of common clay, viz.: that it is the ashes of former organizations of minute life.

Professor Huxley showed the important bearing of these discoveries on the geological construction of the earth. And he further states that, supposing we had a globe covered with water, with no dry land at all, there could be no wear and tear of coasts, no denudations, and no deposit of sedimentary rocks. The sea surrounding the North and South poles would then be covered with thick layers of these animalculæ, able to draw silica from the water, transmute it into skeletons, and then rain a perpetual shower of such siliceous skeletons to the bottom of the water on the sponge spicules. In the intermediate zones a perpetual shower of calcareous shells would fall in the same way. If the sea bottom were depressed until these were entirely dissolved, or the bottom raised, there would be six different kinds of rocks, such as make the larger part of the earth, that would be attributed to the work of these infinitesimal builders alone. These conclusions of Huxley, Newberry, and others, may embrace the correct theory of some siliceous formations.

The soft mud, found by the Challenger—entire shoals of shells, so light that the plummet sunk into it almost as if it had been water—may explain the case referred to by Mantel in his *Pictorial Atlas of Fossils*, of a stream of liquid flint encasing organic forms.

But other questions arise, to which I have not found satisfactory answers. If diatoms and animalculæ clothe themselves with shields and shells of silica, and finally fall to the bottom of the sea, as unconnected particles, how is the additional gelatinous form of silica generated that gives cohesion and compact structure to these infinitesimal particles and forms them into solid masses of flint, as we now find it?

Inasmuch as diatoms have not the power of solidification, cohesion and crystallization, but depend upon some other agent for these conditions, may not that other force separate and arrange silica from the water, and precipitate it to the bottom in a condition to produce the unstratified form flint presents to us, without the aid of diatoms or animalculæ? And if it is conceded that some flints are properly attributed to diatomaceous origin, is it therefore necessary to conclude that they must contribute to the formation of all flint beds that have been discovered? Some specimens of flint that I have collected, and present for your examination, seem to have been formed under a high degree of heat, and are tinged with various colors. Others represent inclosed fossils, mollusks and corals; others, large and beautiful quartz crystals—transparent, pellucid, ferruginous and drusy, with some so small that a microscope is required to see their perfection; while other specimens resemble siliceous sinter, the deposition of thermal springs. But as I have already said, no indication of thermal springs have been found here, and Professor Klippart has made a microscopic examination of this Flint-Ridge silex, and can find no appearance of diatoms in it. His microscope is a powerful one, the same used for years by Agassiz and Lesquereux, in their studies of the hidden secrets of plant and animal life—investigations that have made their names known and honored in the whole world of science.

Silicon, the base of silica, is one of the elementary substances of the globe, nearly allied to boron and carbon in some of its properties, and, next in abundance to oxygen, is unknown in nature in its pure state, but, combined with oxygen, forms silica or quartz. Although infusible and insoluble, many oxides enable heat to melt it down and form glass; or, if but a trace of alkali be contained in waters, those waters, if heated, have the power of dissolving it, and thus dissolved it may spread widely, either to enter new combinations or to fill with quartz fissures and cavities among the rocks, thereby making veins, and acting as a general current and solidifier. As an elementary principle in nature it is found everywhere in proper combination with oxygen, constituting rocks; again, taking part in the construction of plants; associated with oxygen, hydrogen and with alkalies in silicified water; and with nitrogen, oxygen, carbonic acid, and other constituent properties, that make up the gaseous envelope surrounding the earth—the atmosphere which is directly or indirectly the cause of numerous geological observations—the great laboratory in which all meteorological and electrical phenomena are elaborated. In this combination silica ascends and descends with all aqueous and gaseous vapors, while contributing its share to the composition of all organic as well as inorganic substances.

The general theory has been that all the later siliceous deposits owe their origin to the breaking up, attrituration and destruction of previously formed rocks, and that all sandstones and conglomerates are thus prepared, transported by water, distributed and deposited where we now find them. But this theory is being somewhat modified by such scientists as Sterry Hunt, Beaumont, and some others, who conclude that more credit should be given to chemical and less to mechanical action in the formation of sedimentary rocks; and that beside thermal springs many waters contain a large proportion of dissolved silica. Hunt says: "The large proportion of dissolved silica which many waters contain appears in sedimentary deposits, not only replacing fossils, and forming concretions and beds of flint, chert, and jasper, but also in a crystalline state, as is seen in the crystalline quartz often associated with these amorphous varieties, and in some beds of sa. dstone which are made up entirely of small crystals of quartz."

Professor John Brainerd, at the meeting of the American Association for the Advancement of Science, at Cleveland, in 1860, took the same ground in relation to the formation of some sand rocks, and also attributed the origin of the quartz pebbles of the sandstone conglomerate to the same cause, instead of water detrition. His theory was not then adopted, although he presented some irrefutable facts and ingenious arguments in support of his position.

Waters must be highly charged with silica if they hold in solution all the material that is apparently laid down by them in the form of crystalline sandstone, silex pebbles, beds of flint, etc. The decay of vegetable matter, containing minute proportions of silica, may contribute, in some degree, but that would leave a large proportion to have been dissolved from previously formed siliceous rocks, if that is the only source from which it can be derived.

Ever since the days of Homer, history tells us that blood rains have fallen from the heavens, filling men's hearts with fear and awe of some mysterious power that ruled or raged above them. But science, of a comparatively recent date, has allayed our fears, by determining that the reddish dust which, accompanied with rain, produces the blood-showers, are to a great extent made up of microscopic atoms, molecules or organisms, many of them of a siliceous character, the color being due to the presence of red oxide of iron. These showers are sometimes of immense extent. One is described as covering an area of more than a million of square miles; another covering two hundred square leagues, and making an earth deposit of an inch in thickness, or equal to 16,000 cubic feet to a square English mile. No discovered fact or well digested theory accounts for the origin of these showers, or what relation they may hold to some unexplored deposits that have been observed. And if they can not be traced to a terrestrial origin, do not they suggest the probability of being generated, collected, and precipitated from that great laboratory, the atmosphere, or in obedience to some law of the universe evolved beyond that even, as in primeval creation, and that some corresponding accumulation has been showered into the carboniferous sea where these flint specimens were formed, enveloping its organisms and assuming the crystalline and varied forms that are now presented to us. Ehrenberg, who carefully studied this phenomena of "blood-showers," wonderingly asks: "How many thousand millions of hundred-weight of microscopic organisms have fallen from the heavens since the period of Homer?" But if we would look back to the period when the cause and effect of this phenomena was in its fullest force, we should go back beyond the days of Homer, beyond the age of man, backward to that indefinite period when the gaseous envelope of the earth segregated its component elements, formed new combinations, threw back upon the earth its rejected exhalations, or showered upon it the superabundant material it had accumulated from surrounding space, or had evolved from the chemical trituration of its own inharmonious forces.

The Nebular Hypothesis: Its Present Condition. By John J. Plummer, M.A.

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In the whole range of science there is no theory which has attracted so much attention, has passed through so many vicissitudes, and has been so earnestly and fondly supported in the face of opposing evidence, as the nebular hypothesis of Laplace. This has arisen, doubtless, to some extent from the respect due to the very eminent astronomers by whom it was first suggested and promulgated, but perhaps still more to the nature of the hypothesis itself, and to the fact that many otherwise unexplained phenomena find in it a satisfactory solution. The whole course of scientific progress has led us to look for the most simple laws in order to explain the most apparently complicated results; and such a law the nebular hypothesis would become, were it possible to give to it such a high degree of probability as at present serves for the demonstration of the Newtonian law of gravitation, or of the undulatory theory of light. That it may one day attain to this degree of certainty, and be recognized as an established truth, is the hope of many who are fascinated alike by its simplicity and its comprehensiveness—a hope that has often served to sustain it when the bulk of evidence has not appeared to be in its favor, and one in which the writer to some extent indulges, although well aware that it may require to undergo considerable modification before it reaches that exalted position.

Previously to the revelations of the spectroscope, the nebular hypothesis stood at a very low ebb. The gradually increased powers of telescopes, culminating in the gigantic reflector of Lord Rosse, had one by one reduced the number of the so-called nebulæ, by resolving them into clusters of distant stars, very closely packed together, until, although a large number still continued nebulous in appearance under all circumstances, it seemed very probable indeed that indefinitely increased telescopic power was all that was needed to resolve the remainder. Still it retained a few believers, loth to relinquish the insight into the origin of the solar system which it holds out, and ready to sieze at once on the important discovery of true gaseous nebulæ by Mr. Huggins, as direct confirmation of the hypothesis. There can be no question that the proved existence of immense masses of gaseous matter does place the theory upon a much firmer footing than before; at least, the speculations of Sir William Herschel are now established, notwithstanding that the superstructure raised thereon by Kant and Laplace is little, if, indeed, as we shall see further, at all supported by it.

For this important advance in our knowledge we are indebted to the spectroscope. When all other means had failed to give us faithful indications of the existence of remote gaseous bodies, this invaluable instrument at once decided without question that, of the nebulæ unresolved by the largest and most powerful telescopes, a considerable proportion are simply mechanical mixtures of three gases, two of which are well known to us, namely, nitrogen and hydrogen; and the third, although unknown or unidentified, is probably of somewhat similar character—that is, an elementary, nonliquefiable gas. It is not improbable that it may even be a terrestrial element, for our knowledge of the variety of spectra obtainable from the same substance, under different circumstances, is still too deficient to enable us to speak positively on this point. But the spectroscope is capable of telling us still more regarding the nature of the light analyzed by it, and it is here that the evidence it gives is unfavorable to the hypotheses of Laplace. The density of the gas from which the light emanates produces an effect upon the spectrum, and is measured by the breadth of the lines composing it. Now, the nebular hypothesis requires as a necessary corollary—and it has accordingly always been admitted as such—that nebulæ of every degree of condensation should be found in the heavens, and the variations of brilliancy of these bodies has therefore been pointed out as evidence of variation of density. The width of the spectral lines, however, provides us with a much more certain, delicate, and reliable test.

From the observations of Dr. Huggins, it would appear that the bright lines in the nebular spectra present no appreciable difference of thickness in all those cases in which it has been possible to use a very narrow slit. The lines have invariably been found to be exceedingly fine; and hence we are furnished with distinct proof that the gases so examined are not only of equal or nearly equal density, but that they exist in a state of very low tension; facts as I have already stated, which are fatal to the hypothesis. It is, of course, possible that similarly as the numerous lines of the spectra of nitrogen and hydrogen are reduced to two or three in the nebular spectrum, in consequence of the faintness of the light operated upon, so may the width of the lines be diminished from a like cause; but with this I have nothing to do. It is my object merely to show at present, so far as the spectroscope has afforded us increased knowledge of the state of these bodies, it is fatal to the theory, and it remains for those who uphold it in its integrity to establish by experiment that the spectrum of a dense gas, when very faint, not only is reduced to a single line, but that that line itself is narrow when the slit is narrow, as in the case of rarefied gases. Unless the proposition can be established, there remains no alternative but to reject the hypothesis, as an inviting but fallacious guide to the explanation of the origin of the solar system, and to look for some new theory, or for some modification of the old one, for the solution of those problems which it would otherwise afford.

There are still further reasons for believing that the nebular hypothesis in its old form is not altogether trustworthy, and though of less weight, may help to turn the scale, at the same time that they prepare the ground for an altered conception of it, free from these objections. It has been necessary hitherto to assume that the nebulous matter existed originally at a great heat, without suggesting, it seems to me, any sufficient force by which this high temperature was reached. This is, at least wanting in completeness, especially as there is at hand, as I hope to show, the means by which the matter may have been thus raised in temperature. But a still more fatal objection would appear to be, that the glass which have been identified in the nebulæ do not seem to be, in themselves, adequate to form a system such as our own, unless by the addition of foreign matter from without. Probably no advocate of Mr. Lockyer's theory of the disassociation of the material molecules into their primary or truly elementary components by enormous heat, will go so far as to imagine that the two known gaseous constitutents of the nebulæ, together with one other unknown substance, is all that is essential to form a globe such as our own sun, especially when it has been proved that the actual materials required are known to exist in the immediate neighborhood, and appear to have no other use in the economy of the universe than that of forming with the nebulæ suns and systems such as our own.

It is, perhaps, scarcely necessary to point out that it is to the cometary system that I allude as capable of supplying the necessary material from without, as well as of causing the enormous evolution of heat of which I have spoken; but there are one or two misconceptions which must be cleared away before the mind is prepared to admit the possibility of such a circumstance. These misconceptions have reference, firstly, to the distance of the nebulæ from our own system, and hence to their true volume; and secondly, to the magnitude, or rather the mass, of the generality of comets. As regards the former, it has clearly arisen from the unfortunate association of the true gaseous nebulæ with clusters of stars. Of the enormous distances of the latter from us there can be no doubt; but now that an entirely different class of objects has been proved to exist in the heavens, similar only in appearance to the most remote clusters, there can be no reason to suppose that these are at the like distances. Indeed, it would seem more probable that they are actually nearer to us, at least in some instances, than the nearest fixed stars themselves, for the enormous magnitude which must be attributed to such a mass as the great nebula in Orion, if it be supposed to be at a very much greater distance, must act as a bar to such an assumption. Indeed, the mind experiences a sense of relief in believing that the nebulæ are our nearest neighbors, and the uniformity of nature, which does not offer to our contemplation masses of matter incomparably greater than those we have to deal with in the solar system, seems to require that the nebulæ should not be conceived as of such surpassing magnitude. If this be admitted, it brings these objects almost within the range of comets visiting the solar system; but there are, doubtless, in the heavens numerous groups or congeries of comets similar to these, not to speak of those wonders which move in parabolic or hyperbolic orbits, and which only require infinite time to travel infinite distance. Thus the wide gulfs separating star from star, and which appear only to exist to allow of the free revolution of stellar systems, may be the theater not only of the movement of comets, but also of the evolution of new worlds.

The belief in the insignificant mass of most comets, which is also, I think, open to question, is grounded on more substantial reasons. One comet (Encke's) has actually been weighed against the smallest of our planets, Mercury, and has kicked the beam, but perhaps no more unfortunate instance for the experiment could have been selected than this. It is a comet without stellar nucleus, and one that has made so many revolutions round the sun, that supposing, as we have reason for doing, it loses some portion of its matter at each visit, it must clearly have been very much wasted at the time (1842) when Encke made its perturbations by the planet Mercury the subject of his able researches.

The only other comet that has given us a favorable opportunity of weighing it against one of the planets is Lexell's, which in 1767 and 1779 must have approached very near to Jupiter, without deranging to any extent, so far as we are aware, his system of satellites. Laplace has proved that this comet had certainly less than $\frac{1}{500}$th part of the earth's mass, but there is a very considerable difference between this evaluation and the "few pounds or ounces" which we sometimes hear of as a probable estimate of their weight. Let it be further remembered that Lexell's comet, like Encke's, was one of the comets of short period, which are admittedly the least considerable of their class, and we must acknowledge that the belief in the diminutive mass of comets rests upon insecure if not insufficent evidence. The important discovery that comets in their orbits are accompanied by streams of meteors, and that they themselves are either meteors of very unusual size, or a dense cluster of such bodies, proves that they must have a mass at least comparable with, if they do not often exceed, that given by Laplace as the maximum possible for Lexell's comet.

Having to some extent removed these misconceptions as to the masses of the comets and of the nebulæ, it is next to be considered whether the cometary systems are capable of supplying the nebulous matter with the requisite material for the formation of new suns, and here our imperfect knowledge of the constitution of the former acts as a serious drawback. It would seem certain, however, that the composition of comets is very various. One substance alone that is known to us at present has been discovered, from spectroscopic analysis, as existing in comets, and to form it would appear, in those cases in which it is found, the sole constituent. This substance is carbon,* but it has been identified only in three or four comets out of a considerable number whose spectra have been examined. The great comet of the past year is one of those whose spectrum has been thus identified. Others have yielded spectra which, being simple in character and very similar in appearance to that of carbon, may possibly belong to some substance of analogous properties; at least, it is likely that a single uncombined element will be found, on increased knowledge, to form their principal or sole constituent. Again, it is not improbable that other comets may be of like composition to the meteors, many of which have been analyzed by the ordinary methods of the chemist; but whether this is so or not, since these latter follow in the track of comets, they must suffer the same catastrophes. The meteors that have fallen upon the

* It is often stated that the material of comets yielding the carbon spectrum must be a hydro-carbon; but it is to be remarked that none of the lines of hydrogen have ever been seen, and the assumption is therefore an entirely gratuitous one, made to get over the difficulty of the refractory nature of carbon.

earth have been found to contain a large number of terrestrial elements —iron, in a native, uncombined form, and in great quantity; cobalt nickel, sulphur, silica, in the form of augite; molybdenum, tin, copper, and a number of other metals in smaller quantity. All these are substances of an entirely different character from those elements identified as composing the nebulæ. The former are among the most refractory of chemical elements; the latter quite defy our utmost attempts to liquefy them. In both they appear to exist in an uncombined form, though their union would go far to supply the materials of a world such as ours. Some important elements, as oxygen,* are wanting, it is true; but it must be remembered that we know already of two important constituents which we are unable to identify with terrestrial elements, namely, the substance which at least as frequently as carbon is found the sole component of comets, and the gas equally known which exists along with nitrogen and hydrogen in the nebulæ.

Although in the system of Laplace the cometary element held only a very subordinate position, it must not be imagined that it was neglected altogether. On the contary, Laplace, with that far reaching power of generalization which is characteristic of great minds, perceived that the encounter of comet with nebula was inevitable, and the mechanical problem of the diminution of velocity, in consequence of the former moving impeded through the gases of the latter, received from him much attention. He perceived that a comet once within the power of attraction of a nebula had no chance of escape, but must revolve around its center of gravity in an ever diminishing spiral; but, unacquainted with the peculiar chemical constitution of these bodies, it was impossible for him to carry his speculations further. In the light of modern discovery we may perceive, however, that the assimilation of comets into the nebulous matter, foreseen by Laplace, will be much more rapidly expedited, and that, notwithstanding the augmentation of temperature produced by friction, a still more considerable evolution of heat will result from the chemical union of the two. We can not pretend to explain the exact chemical effects produced by the impact, owing to our ignorance of some of the substances themselves; but, in any case, an enormous development of heat is certain to result: and whether the compound thus formed assumes the liquid or retains the solid form, it will certainly be of greater specific gravity than the rest of the nebula, of which it may now be said to form a part, and the revolution around the center of gravity of the mass will be conducted precisely

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* Except as combined with silicon.

as indicated by Laplace. Those familiar with the extraordinary convolutions of many of the nebulæ will not fail to see how easily many such appearances may be explained, by imagining a long stream of meteoric bodies in the track of a comet pouring into the nebulous matter, and being retarded and absorbed in their passage through it. There is good reason to suppose that the product of chemical union assumes generally the liquid, rather than the gaseous form, since it has frequently been noted that a faint, continuous spectrum may be discerned along with that of the bright, gaseous lines in many nebulæ, and which is not confined to any particular portion of them.

We may now pretty clearly depict the condition of a nebula according to this hypothesis, when after the lapse of many ages a large number of comets and accompanying meteor-streams have been absorbed into its substance. It will consist of a greater or less residue of the original gaseous constituents, which, for reasons well known to spectroscopists, will still continue to yield most conspicuously the characteristic bright line spectrum, and dispersed throughout the mass an immense number of liquid nuclei, all tending toward the common center of gravity in spiral orbits, the center being occupied by a brilliant white-hot liquid mass. The temperature of such a nebula will be much higher than of one less developed—a fact which will tend to keep the density of the gaseous constituents at nearly the same level, in spite of the increased gravitational tendency to condensation near the center. We may even conceive that this intense heat might be sufficient to render gaseous the liquid nuclei, when a numerously bright-lined spectrum should make its appearance, but it would then be necessary to assume that the faintness of the spectrum would make it difficult to distinguish the difference between this and one truly continuous. We may, on the contrary, imagine the well-developed nebula to become a compact, liquid mass, in this case also yielding a continuous spectrum. Nor does it seem unlikely that a considerable number of bodies in this latter state of existence may actually be discovered in the heavens. Many nebulæ, after having resisted the utmost efforts of astronomers, armed with the largest telescopes, to class them among the clusters of stars, have equally refused to be entered in the list of true nebulæ by yielding the discontinuous spectrum, and whose real condition remains, therefore, for the present an enigma. Of the two suppositions, the second appears to me to be the most probable; yet, if it be accepted, it will be necessary to reconstruct the nebular hypothesis, if it can still be maintained under the altered circumstances. There are, however, some facts which tend strongly to show that the first suggestion is the more correct one, or, in some cases at least, more closely approximates to the true condition of things. It is well known that the great nebula in Andromeda—one of those which defy alike the powers of the telescope and spectroscope—presents a very anomalous spectrum. Though apparently continuous, some portions of the red and orange are altogether wanting, and the more refrangible portion consists of a mottled band, with uneven gradation of intensity. This is very much what would be expected if the spectrum were really one of numerous bright lines, nor is it a singular instance. Several other nebulæ have given rise to strong suspicions of a similar constitution; and no theory, so far as I am aware, has hitherto been advanced in explanation of these appearances. I need not point out that if this supposition is correct, a state of things arises in which the nebular hypothesis in its later form will again apply, with the addition only that the gases of the nebulæ are in a much more complicated condition than was formerly supposed to be the case.

It is to be remarked that the number of comets which would be attracted to a nebula would increase in proportion as its mass increased with each succeeding capture, so that its development would proceed at an accelerated rate until a certain point was reached, when comparatively little of the gaseous elements remain. The comets would then describe their orbits around the newly formed sun, and would leave only their smaller or outlying meteorites to swell its mass. But even these would greatly tend to compensate for the dissipation of heat by radiation, and would much retard the cooling process—a state of things that will continue to exist even in a perfectly formed system, such as our own. I am thus led to regard the meteoric theory of the supply of solar heat as a part of the modified nebular hypothesis which I have suggested. If our sun is a nebulous star, surrounded by a far-extending atmosphere, in which are revolving a large number of meteoric bodies, visible possibly to us, as the Zodiacal Light, the materials for keeping up a constant or nearly constant temperature for a considerable length of time are at hand, and every succeeding comet will add some to the number of those meteors which, unlike it, are unable to make their final escape, and pursue their orbits with scarcely diminished velocity. The smaller meteors in a stream, as presenting relatively a larger surface, will be more retarded than the larger, and will more rapidly fall upon the solar surface—so rapidly, indeed, that it does not seem unlikely that the universally held belief in the increased solar heat during years noted for large comets may have a sound foundation. Such a possibility is sufficient to invest the movements of comets with great practical interest, and the various circumstances producing the increased heat of such seasons must give rise to important investigations. Thus we should come to look upon the nearness of approach of a comet in perihelion, as an essential element in such a discussion, and perhaps also the material composition of the comet itself. It has been suggested, with much show of reason, that the larger and nearer planets when in perihelion simultaneously have a considerable effect upon the solar surface, by producing spots, etc., and these again, in determining the amount of heat radiated from the sun; may we not, therefore, expect that the arrival in perihelion of a comet from most remote regions, which, if of smaller mass, often approaches the sun much more nearly than they, may also produce a marked effect on the state of the solar atmosphere? Although the 11-year period of solar spot frequency is too well marked to admit of any question, there is already much evidence to prove that there exist many minor disturbances, secondary maxima and minima of solar activity, which remain to be explained, and which may possibly be due to the occasional and irregular approaches of comets. It is certain that the solution of no question can be of more service to the advancement of science than that of the real practical utility of comets in the economy of the universe. Speculation on this point has already been too long neglected, and unless it is carried on now as far and as correctly as the state of modern science allows, it is certain that it will mask some other results and hinder progress. Surely none can believe that these bodies are mere *ignes-fatui*, coming and going, without being of any service to us or to other systems; and although much mystery has always hung about them, and still baffles our researches, perhaps the best way of attaining to the solution of it is by searching for some purpose that they may subserve. Without attempting altogether to set up the nebular hypothesis in as favorable a light as before, the above remarks and speculations may serve to indicate the position in which it stands at present, and the broader basis on which in future the question must be argued. A certain degree of unity of design seems to result from these theories, which is consonant with the order of nature. Every known body in the universe appears to have an important and appropriate function to perform in the development or maintenance of system like our own—a function that is constant in all conceivable states of existence of those systems; and while my speculations do not contradict the various theories of others, they show a tendency to unite them into one consistent whole. Perhaps the most distinctive feature of these remarks is, that the effects I speak of must actually take place, whether or not they have the importance here attached to them. No one will deny that the nebula and the comet will constantly come into contact; and were we acquainted with all the materials so meeting, it would be a comparatively simple problem for the chemist to determine what compounds would result, and for the physicist to show in what state, gaseous or otherwise, they would afterward remain. Both these questions require to be answered satisfactorily before it is possible to declare whether the celebrated hypothesis of Laplace is or is not the true key to the solution of the formation and history of the solar system; and for these answers, at the present, it waits.

EDITORIAL MISCELLANY.

ARCHÆOLOGY.—From a recent article in *Harper's Magazine*, we reproduce in substance several interesting statements concerning the antiquities of the Mississippi Valley: Near Osceola, Arkansas, in the vicinity of a great artificial mound, is a level area of ten acres paved with adobe, and supposed to have been constructed and used as a threshing floor, in connection with bins or storehouses, whose remains are still to be observed in the vicinity. The paved floor is covered with black loam to a depth of two and a half feet, and experiments are being made with a view of approximating the age of the works by a method heretofore suggested in these columns, namely: measuring, by repeated observations and experiments, the annual deposit of loam from decaying forest vegetation in given districts.

The old river channels of the Mississippi, formed by successive changes of the current, are to be distinctly traced between Memphis and the ridge 40 miles west, at whose base flows the St. Francis river. Everywhere upon the intervening lowland are observed the mounds and *aguadas* of the ancient people, from which the inference is drawn that they were built after the Mississippi had reached a channel five miles west of its present bed. These remains extend southward only as far as Baton Rouge, and, assuming that within a comparatively recent geological period the Gulf of Mexico extended far up the present valley of the Mississippi, it is inferred that Natchez or Baton Rouge stand at what was in the Mound-Builders' era the head of this extension of the Gulf—a present distance of three hundred miles. Calculating the annual sedimentary deposit at two hundred linear yards, and assuming this rate to have been uniform, a period of three thousand years is supposed to have elapsed since the abandonment of these works.

The prairies along the White and Arkansas rivers are dotted with the remains of once populous cities, whose outlines may be readily traced in the foundations of dwellings with avenues between. Beside countless smaller elevations the lowlands west of Memphis contain many mounds varying from 40 to 60 feet in altitude. In the swamps, covered with decayed vegetation, are found remains of brick structures; and the highway opened years ago by Gen. Gaines, follows an artificial roadway lifted above the flood-tide of the Mississippi by the ancient race.

Many interesting relics of primitive art are found which exhibit a singular beauty of workmanship, but do not differ materially from those discovered in other localities. Among these, however, are some whose evident uses throw new light upon the customs of the aborigines. Earthen vessels, very thin and light, from graves near Osceola, when suspended in the air on a hot day are found to render contained water exceedingly cold by rapid evaporation through the porous clay—a use clearly indicated by the peculiar shape of the vessels. A "bronze" (copper?) idol from a mound near Fulton, Tennessee, singularly resembles Japanese workmanship and design. In the same mound was found an earthen box with close-fitting lid, containing "pills." A skeleton beside it crumbled on exposure to the air. The pills were sent to Cincinnati for analysis, but the result was never ascertained. A crucible, showing marks of use, and containing glistening particles of molten metal, and a narrow necked vessel with glossy surface, resembling Etruscan ware, are also described.

Wheat, grown on the banks of the Mississippi from grains taken out of an ancient Egyptian sarcophagus, possesses stalks and leaves resembling miniature Indian corn or sorghum; and the writer quoted, speaking, as is alleged, with specimens so grown before him, asserts that the same wheat, degenerate, but perfect in all its incidents, still grows among the weeds and grasses that cover the works on the lowlands referred to, eighteen miles west of Memphis. A mound, sixteen miles east of Little Rock, Arkansas, is 250 feet in height. Another near by, 100 feet in height, is a truncated square pyramid, whose summit is an acre in area.

Colorado Antiquities.—The results attained by the First Division of the Geological and Topographical Survey of the Territories include the discovery of numerous ruins of towns and dwellings of extinct races who inhabited the mésas and cañons, sometimes elevated a thousand feet vertically above the stream below. Remains of glazed pottery, and the structure of these dwellings and fortifications indicate a more advanced state of art than was possessed by any of the modern Indian tribes.

The Second Division, under Mr. Powell, is still in the field, and the full results of its labors can not be given. They include similar discoveries in the valley of the Colorado, besides the collection of many specimens of ancient picture-writing, implements, etc., and photographs of cave dwellings in the cliffs near the St. Elmo, and the ruins of dwellings and fortified places elsewhere.

Ancient Lake Basins.—Prof. C. C. Marsh contributes to a recent issue of the *American Journal of Science and Arts* the first part of an interesting paper on "Ancient Lake Basins of the Rocky Mountain Region." The geological explorers of the "bad lands" have established the existence of several basins of tertiary fresh-water lakes, which Prof. Marsh briefly discusses under the three divisions: Eocene, Miocene and Pleiocene, corresponding with their relative age. He states that the general characteristics of these basins indicate successive elevations and depressions of the surface, which sometimes brings into juxtaposition deposits of widely separated periods. Thus, the Green River basin, lying between the Rocky Mountains and the Wasatch Range contains deposits of great thickness, yielding 140 species of extinct Eocene vertebrates, while, overlying the eroded deposits, are strata composed of water-worn debris of the surrounding mountains of a comparatively recent period.

The fauna of the Eocene lakes indicates a tropical climate, and includes a great number of animals of the tapir kind, monkeys, crocodiles, lizards and serpents. The flora seems not yet satisfactorily determined.

The Miocene lake deposits contain the wonderful vertebrate fauna, made known chiefly through the researches of Prof. Hayden, of the recent military exploration. These basins indicate comparatively shallow and quiet waters. In these, also, there is evidence of the lake bottom having for a long period been exposed as dry land to the erosive action of rains, but subsequently submerged and reconverted into a lake, which deposited extensive beds of clay and sand over the same area.

The fauna of the White river lake basin indicates a climate less tropical than that of the Eocene lake, as seen in the absence of monkeys and scarcity of reptilian life. The Brontotheridæ, the largest known Miocene mammals, are peculiar to the lower strata of this basin.

The Pleiocene basins were formed by a subsidence east of the Rocky Mountains at the close of the Miocene period, forming an extensive lake, covering the eastern Miocene basin, and extending southwardly nearly to the Gulf of Mexico. The strata of this deposit are cut through by the river Niobrara for two hundred miles of its course. They are horizontal, light in color, and much more arenaceous than those of the Miocene below. The upper strata consist of hard sandstones or calcareous grits, which wear but slowly, and hence still form the great table-lands over much of the interior of the basin. Prof. Marsh states that he has traced these high plateaux and the isolated buttes from near the Black Hills south to the Arkansas river, and found them all of the Pleiocene age. The fauna here indicates a warm, temperate climate, and includes the mastodon, rhinoceros, camels and horses; remains of the latter being especially abundant.

ACOUSTICS.—Professor Tyndall contributes to the *Contemporary Review* a paper of great interest on "The Atmosphere in Relation to Fog-Signaling." He states that during the last ten years no less than 273 vessels have been lost on the British coasts, and estimates the loss as far greater on the American seaboard, as the direct result of fogs and thick weather. The im ortance, therefore, of the efforts to find an effective substitute for light in sound-signals to warn sailors approaching a dangerous coast can not be overestimated. With this view, experiments were commenced in 1873, at the South-Foreland, near Dover, with two powerful magneto-electric lights worked by steam power, and trumpets, air and steam whistles. In addition to the apparatus supplied by the British government, the Light-House Board of our own country sent a steam-siren similar to those used in our light. house system, and which he thus describes:

"The principle of the siren is easily understood. A musical sound is produced when the tympanic membrane is struck periodically with sufficient rapidity. The production of these tympanic shocks by puffs of air was first realized by Dr. Robinson, and his device was the first and simplest form of the siren. A stop-cock was so constructed that it opened and shut the passage of a pipe 720 times in a second. Air from the wind-chest of an organ being allowed to pass along the pipe during the rotation of the cock, a musical sound was most smoothly uttered. A great step was made in the construction of the instrument by Cagniard de la Tour, who gave it its present name. He employed a box with a perforated lid, and above the lid a similarly perforated disk capable of rotation. The perforations were oblique, so that when wind was driven through the lid, it so impinged upon the apertures of the disk as to set it in motion. No separate mechanism was therefore required to turn the disk. When the perforations of lid and disk coincided, a puff escaped; when they did not coincide, the current of air was cut off. In this way impulses were imparted to the air, and sound-waves generated. The siren has been greatly improved by Dove, and specially so by Helmholtz. Even in its small form, it can produce sounds of great intensity.

"In the steam-siren, as in the ordinary one, a fixed disk, and a rotating disk are employed, but radial slits are used instead of circular apertures. One disk is fixed vertically across the throat of a conical trumpet 16½ feet long, 5 inches in diameter where the disk crosses it, and gradually opening out till at the other extremity it reaches a diameter of two feet three inches. Behind the fixed disk is the rotating one, which is driven by separate mechanism. The trumpet is mounted on a boiler. In our experiments, steam of 70 lbs. pressure was for the most part employed. Just as in the ordinary siren, when the radial slits of the two disks coincide, and then only, a strong puff of steam escapes. Sound-waves of great intensity are thus sent through the air, the pitch of the note depending on the velocity of rotation."

To these instruments were added three guns—an 18-pounder, a 5½-inch howitzer, and a 13-inch mortar.

The comparative tests to which these instruments were subjected at first resulted in favor of the guns, which were heard at a distance of nearly ten miles, while under other atmospheric conditions the trumpets proved superior—the "selective power" of the atmosphere being more noticeable in autumn than in summer. The results, however, were for a time, inconstant and unsatisfactory, and with hardly a gleam of principle to connect them.

"It is," says Prof. Tyndall, "as already shown, an opinion entertained in high quarters, that the waves of sound are reflected at the limiting surfaces of the minute particles which constitute haze and fog, the alleged waste of sound in fog being thus explained. If, however, this be an efficient practical cause of the stoppage of sound, and if clear, calm air be, as alleged, the best vehicle, it would be impossible to understand how, to-day, in a thick haze, the sound reached a distance of twelve and three-fourths miles, while on May 20, in a calm and hazeless atmosphere, the maximum range was only from five to six miles. Such facts foreshadow a revolution in our notions regarding the action of haze and fogs upon sound."

The explanation, however, was not long deferred. On July 3, it was determined that the vapor generated at the surface of the sea by the sun's rays, rising and breaking through the air at various points, presented the conditions of limiting surfaces producing partial echoes and a consequent waste of sound.

Other observations demonstrated the existence of acoustic clouds, filling the optically transparent atmosphere, and causing distinct echoes of great intensity and long duration, to which the rolling of thunder is to be ascribed.

"But the strength of science," says Prof. Tyndall, "consists in verification, and I was anxious to submit the question of aërial reflection to an experimental test. As in most similar cases, it was not the simplest combinations that were first adopted. Two gases of different densities were to be chosen, and I chose carbonic acid and coal gas. With the aid of my skillful assistant, Mr. John Cottrel, a tunnel was formed, across which five-and-twenty layers of carbonic acid were permitted to fall, and five-and-twenty alternate layers of coal gas to rise. Sound was sent through this tunnel, making fifty passages from medium to medium in its course. These, I thought, would waste in aërial echoes a sensible portion of sound.

"To indicate this waste an objective test was found in a gas-flame brought to the verge of flaring. The action of sonorous vibrations on such a flame was discovered by Professor Le Conte in the United States, who had the sagacity to seize upon the most essential features of the phenomenon. A similar observation was subsequently made by Prof. Barrett, while assistant in the physical laboratory of the Royal Institution; and both he and myself, my present assistant, Mr. Cottrell, and Mr. Philip Barry, have succeeded in pushing such flames to an extraordinary degree of sensitiveness. The following brief description of a sensitive flame, 24 inches high, issuing from the single orifice of a steatite-burner, is taken from my forthcoming 'Lectures on Sound:' 'The slightest tap on a distant anvil causes it to fall to seven inches. When a bunch of keys is shaken, the flame is violently agitated, and emits a loud roar. The dropping of a sixpence into a hand, already containing coin, knocks the flame down. The creaking of boots sets it in violent commotion. The crumbling or tearing of a bit of paper, or the rustle of a silk dress does the same. Responsive to every tick of a watch held near it, it falls and explodes. The winding up of the watch produces tumult. From a distance of thirty yards we may chirrup to this flame, and cause it to fall and roar. Repeating a passage from the 'Faerie Queene,' the flame sifts and selects the manifold sounds of my voice, noticing some by a slight nod, others by a deeper bow, while to others it responds by violent agitation."

The exceedingly interesting experiments which are detailed, relate to the action of layers of air, saturated with the vapors of various volatile liquids, in the transmission of sound.

"Thus far," concludes the distinguished professor, "we have placed our subject in the firm grasp of experiment; nor shall we find this test failing us further on."

Primitive Conceptions.—In his forthcoming work on "Principles of Sociology," Herbert Spencer strikes at the root of those false theories of education which lead our teachers to ply the juvenile mind with generalities, before it has acquired those concrete facts to which they refer. "When we see mathematics introduced under the purely rational form, instead of under that empirical form with which it should be commenced by the child, as it was commenced by the race—when we see a subject so abstract as grammar put among the first, instead of among the last, and see it taught analytically, instead of synthetically, we have ample evidence of the prevailing inability to conceive the ideas of undeveloped minds."

From this, the distinguished essayist proceeds to trace the origin and growth of primitive ideas among savage nations in some of their leading traits, conceiving the surroundings as they appeared to the primitive man. Taking natural occurrences, such as vanishing of clouds, appearance and disappearance of the heavenly bodies, falling of rain, mirages, waterspouts, winds, etc., he endeavors to delineate the mental associations which would naturally arise in the primitive mind, by observing the impressions produced upon the minds of young children by similar phenomena, and continues:

"Significant facts of another order, from time to time disclosed, may next be noted — facts irresistibly impressing the primitive man with the belief that things are transmutable from one kind of substance to another. I refer to the facts forced on his attention by embedded remains of animals and plants.

"While gathering food on the sea-shore, he finds, protruding from a rock, a shell which, if not of the same shape as the shells he picks up, is so similar that he naturally classes it with them. But, instead of being loose, it is part of a solid block; and, on breaking it off, he finds its inside as hard as its matrix. Here, then, are two kindred forms, one of which consists of shell and flesh, and the other of shell and stone. Near at hand, in the mass of clay *debris* detached from the adjacent cliff, he picks up a fossil ammonite. Perhaps, like the *Gryphœa* just examined, it has a shelly coating with a stony inside. Perhaps, as happens with some liassic ammonites, of which the shell has been dissolved away, leaving the masses of indurated clay that filled its chambers locked loosely together, it suggests a series of articulated vertebræ coiled up; or, as with other liassic ammonites of which the shell has been replaced by iron pyrites, it has a glistening appearance like that of a snake's skin. As such fossils are sometimes called "snake-stones," and are in Ireland supposed to be the serpents St. Patrick banished, we can not wonder if the uncritical savage, classing this object with those it most resembles, thinks it a transmuted snake — once flesh and now stone. In another place, where a gully has been cut through sandstone by a stream, he observes on the surface of a slab the outline of a fish, and, looking closely, sees scales and the traces of fins; and elsewhere, similarly imbedded in rock, he finds skulls and bones not unlike those of the animals he kills for food; some of them, indeed, not unlike those of men.

"Still more striking are the transmutations of plants occasionally discovered. I do not refer so much to the prints of leaves in shale, and the fossil stems found in strata accompanying coal; I refer, more especially, to the silicified trees here and there met with. Retaining not their general forms only, but their minute structures, so that the annual growths are marked by rings of color such as mark them in living stems, these yield the savage clear evidence of transmutation. With all our knowledge, it remains difficult to understand how silica can so replace the components of the wood as to preserve the appearance thus perfectly; and for the primitive man, knowing nothing of molecular action, and unable to conceive a process of substitution, there is no possible thought but that the wood is changed into stone."

These, and kindred phenomena, such as development from the egg, shadows, echoes, etc., it is argued, lead the uncultured mind to belief in a dual existence, which is formulated in the superstitions of all savage tribes, and may thus be referred to as general and inevitable process of mental evolution.

BOOK NOTICES.

THE NATIVE RACES OF THE PACIFIC STATES OF NORTH AMERICA. By Hubert Howe Bancroft. Vol. 1., Wild Tribes. Price, $5 50. D. Appleton & Co., New York.

Those interested in the ethnology of the American aborigines will receive with pleasure the announcement of a series of five volumes, presenting, in a condensed and accurate form, the gleanings of a library of 16,000 books, pamphlets and manuscripts, collected by Mr. Bancroft, with especial reference to the task whose first fruits are now before us.

Students of the earlier civilizations of the New World have heretofore encountered almost insurmountable difficulties, arising from the paucity of available sources of information. The aboriginal civilization, whether we conceive it as radiating northeastward from tropical America, or southeastward from a lodgment on the Pacific coast, in either case, emanated from a point farthest removed from the original center of the later European culture implanted on this continent, and therefore, least accessible to the spirit of modern investigation, until almost all vestiges were lost. In Mexico and Central America, the Aztec and Maya-Quiché civilizations were literally obliterated by the crushing blight of Spanish avarice and superstition. In addition to these difficulties, the archæology of our prehistoric races has long rested under an indifference. which has permitted even the decaying monuments of their former empires to be defaced by time, or ruthlessly destroyed by so-called modern improvement.

Recent archæological discoveries in other countries, however, bringing to light many curious and hitherto unsuspected facts, and enlarging the boundaries of positive history among Eastern nations, have awakened an interest in our own autochthones, and created a demand for a species of information which Mr. Bancroft's work promises to supply. The work thus appears at a time when a growing want is felt for the information he offers as the result of his laborious and extended examination. Dealing with the aboriginal people who dwelt nearest to what we may regard as the primal seat of the ancient civilization, his object, as expressed in his own words, is, "to gather and arrange in a systematic, compact form, all that is known of these people; to preserve some facts, perhaps, from oblivion; to bring others from inaccessible nooks, and to render all available to science and to the general reader."

The volume before us treats of the tribes who inhabited the entire Pacific coast of North America, whom he divides into seven distinctive groups, namely: I. Hyperboreans; II. Columbians; III. Californians; IV. New Mexicans; V. Wild Tribes of Mexico; VI. Wild Tribes of Central America; and VII. Civilized Tribes of Mexico, which latter class will form the subject of a separate volume.

The nations thus grouped for convenience of treatment, are represented under those characteristics which distinguished them at the time of their first intercourse with Europeans, and the facts presented pertain exclusively to the observed traits, physical and mental peculiarities, customs, and external surroundings of the tribes in question. Each group is treated in a separate chapter, with an excellent map and supplemental division describing tribal boundaries.

Mr. Bancroft's style is concise and vigorous, and his facts are stated comprehensively, yet without circumlocution. In presenting the varied mass of details, which necessarily form the staple of his work, he has succeeded admirably in weaving them into the semblance of a connected narrative, that can not fail to interest even the general reader. The more minute and technical facts are stated, with references to authorities, in foot notes and in the appendix supplementing each chapter.

The precise value of the work before us, in a scientific point of view, although unquestionably very great, can not be determined without a more extended and critical examination than can as yet be given. We take pleasure, however, in recommending the work to our readers, as one well worthy of study, by those who would acquire a comprehensive knowledge of our aborigines, as well as by those engaged in pursuing a special line of investigation, and shall have occasion to refer more specifically to the work hereafter.

OUR BARREN LANDS. By Gen. W. B. Hazen. Paper, 53 pages. Price, 50 cents. Printed and for sale by Robert Clarke & Co., Cincinnati.

By a careful and conclusive collation of meteorological and agricultural statistics, extending over a number of years, Gen. Hazen completes the overthrow of the exalted claims made in behalf of the "Northern Tropical Belt." His rejoinder to Gen. Custer's nine-column article in the *New York Tribune* is pointed and pungent, and shows that Custer's statements were based upon the experience of a single and exceptionally favorable season, and hence, of no practical value.

THE DOCTRINE OF EVOLUTION: Its Data, its Principles, its Speculations, and its Theistic Bearings. By Alexander Winchell, LL. D. New York: Harper & Brothers.

In this little volume, the author presents a popular and condensed statement of the theories of evolution as bearing upon theistic dogmas. In the discussion of the relation of the evolutionary doctrines to theism, Prof. Winchell holds that there is necessarily no conflict between religion and science, but that, on the contrary, "Christian theism has nothing to fear, but only new truths to gain."

POPULAR SCIENCE MONTHLY. D. Appleton & Co., Publishers, New York. $5 00 per annum.

This deservedly popular magazine fully sustains the high character established at the outset. As a medium for instilling a love of science in the mind of the great lay-public, it has fulfilled the warmest hopes of its friends, and amply merits the great success achieved.

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Atlantis: A Statement of the "Atlantic" Theory Respecting Aboriginal Civilization. By L. M. HOSEA.

The age in which we live is preëminently one of experimental investigation. Men are no longer content to accept theories unless founded upon a basis of fact amounting almost to positive demonstration. But while modern methods of practical investigation have so enlarged the boundaries of physical science, it is hardly probable that human effort will ever be able to dispel entirely the obscurity which enshrouds the primitive history of man. Yet the labors of the archæologist and geologist have not been altogether in vain. Much has been done in our own time to clear away the undergrowth of preconceived error, and admit the sunlight of truth into the dark regions of superstition and tradition.

The same critical and experimental spirit which has effected so marvelous a change in natural science within a comparatively brief period, while it has upset many cherished beliefs and exploded many phlogistic theories, has given us clearer conceptions of the condition and development of man within the historic period, and proved his existence long anterior to received dates. Indeed it would appear to be satisfactorily established, that man was co-tenant of the earth with extinct mammals of geologic periods; and it seems not improbable that his occupancy of the earth will be still further ante-dated.

But while the prying curiosity of our age has shattered many false theories, it is not without value, also, in rescuing truth from the clutches of error and in establishing that as true which had long been regarded as false. Wendell Phillips, in his interesting lecture on the "Lost Arts," illustrates this point by an anecdote of Archimedes, of whom it is said that when the ships of the enemy besieging Syracuse drew away from the levers he had arranged to pry them out of water, he turned upon them the sun's rays focalized by concave mirrors, and thus set fire to them. This story, so long discredited on account of its alleged physical impossibility, he shows to be true, so far, at least, as this objection to its truth is concerned, by an experiment of certain French scientists who succeeded in fusing lead at the distance of three hundred feet by the same means.

Again, the long disputed existence of Troy, outside of the glowing periods of Homer, seems to be now satisfactorily demonstrated by the researches of Dr. Schliemann, which have not only laid bare the foundations of Ilium's once lofty towers, but show that they were themselves reared upon the debris of a civilization old when Troy was born—a civilization unknown to history and lost even to tradition.

Recent discoveries, also demonstrate the truth of the traditional history of Rome current among the educated classes of the capital during the Augustan age. Explorations conducted at the expense of the late Emperor of the French, and of the Russian government, during the last twenty years, show that even in the time of the Kings, Rome was a fortified city of great importance and immense population. The wall of Romulus, so long considered a myth like the suckling wolf, is disclosed to view, corresponding in detail with the description given by Dionysius of Halicarnassus—the stones composing it being each a "cart load," and so described in the technique of the Roman masons to-day.

But in Egypt the most interesting results of modern archæological investigation have been achieved, and these relate more nearly to the subject of our present discussion. On the banks of the mysterious Nile, the patient labors of Auguste Mariette, formerly a Lieutenant of French Engineers, have been crowned with a success which sets at rest many heretofore doubtful points, and, besides, opens to us new lines of historical and ethnological inquiry.

"Unwearied digging," says Bayard Taylor, "has enabled Mariette to reach the records of the ancient empire, and to show—what we never before suspected—that the glory of Egyptian art belongs to the age of Rameses II. (Sesostris). Not only the art, but the culture, the political organization of Egypt, are carried back to the third dynasty, (4,450 B. C.) and Menes, the first historic king, dawns upon our knowledge, not as a primitive barbarian, but as the result of a long stage of unrecorded development. I do not hesitate to say, that since

Champollion discovered the key to the hieroglyphics, no scholar has thrown such a broad and clear light upon Egyptian life and history as Mariette." Scholars have universally discredited the antiquity claimed by the early Egyptian priesthood for their nation and civilization; but the researches of Mariette, so far as they extend, corroborate the chronological table of the priest Manetho back to a period 5,000 years B. C. when the art remains indicate a proficiency equaled at no later date, and clearly "the result of a long stage of unrecorded development."

Archæological inquiry upon the remains scattered over this continent has reached, as yet, no definite or satisfactory result. Thus far the interpretation of these records of antiquity has practically baffled the closest scrutiny. Yet whoever attempts to unravel the mystery in which the history and ethnology of the builders of the ancient mound-structures of this continent are involved, can hardly fail to become satisfied:

1. That the Mound Builders and the ancient inhabitants of Mexico and Central America were substantially one people, partaking of the same culture; and

2. That the earliest civilization of tropical America, so far as we can comprehend it through the medium of the Aztec and kindred races, presents features which negative the supposition of indigenous and unaided growth.

In view of these conclusions in which investigators have very generally concurred, the inquiry naturally arises, whence obtained these ancient nations these peculiar features of their civilization? Leaving out of view the claim, so strongly urged half a century ago, respecting the original unity and subsequent dispersion of the human race, by which all analogies between ancient civilizations were sought to be explained, as a fact removed by modern investigation to a period of human history too remote to enter as a profitable element into present consideration, we may inquire what evidence, if any, exists, to show that the early American civilization was influenced by external communication.

In response to this inquiry, our attention has been at various times directed by classic antiquaries to the tradition of the Atlantic isles, narrated by Plato in the Timœus as received by Solon from the Egyptian priests of the Delta, during a visit thither by the Athenian law-giver. These priests, as we are informed by Plato, claimed for their country and race a great antiquity, with written records extending back 8,000 years, and traditions of events 1,000 years earlier.

"These writings," said they to Solon, "relate what a prodigious force your city (Athens) once overcame, when a mighty, warlike power, rushing from the Atlantic sea, spread itself with hostile fury over all Europe and Asia. That sea, indeed, was navigable, and had an island fronting that mouth which you, in your tongue, call the 'Pillars of Hercules'; and this island was larger than Lybia (Africa) and Asia (Minor) put together, and there was a passage for travelers of that day to the rest of the islands, as well as from these islands to the whole opposite continent"— (or, more literally, *the continent beyond*)— "that surrounds the real sea. For as respects what is within the mouth here mentioned" (*i. e:* the Mediterranean)—"it appears to be a bay with a kind of narrow entrance; and that sea is indeed a true sea, and the land that entirely surrounds it may truly and most correctly be termed a continent. In this Atlantic island there was formed a powerful league of kings, who subdued the entire island, together with many others, and parts, also, of the continent; besides which, they subjected to their rule the inland parts of Lybia as far as Egypt, and Europe as far as Tyrrhœnia (Italy). The whole of this force then being collected together in one league, undertook to enslave both your country and ours, and the land besides which lies within the mouth. * * * Subsequently, however, through violent earthquakes and deluges, which brought desolation in a single day and night, the whole of this warlike race was at once merged under the earth; and the Atlantic island was itself buried beneath the sea and entirely disappeared; whence now that sea is neither navigable nor to be traced out, being blocked up by the great depth of mud which the subsiding island produced."

Plato evidently regarded this tradition as true, but his modern translators, almost without exception, hold, with Mr. Davis, of King's College, Oxford, that "the whole story of the Atlantic isles is so improbable, and so at variance with the geographical knowledge of the Greeks, even in Plato's time, that it can only be regarded as a mere myth." Other objections have been urged against the truth of this tradition, among which is the suggestion of M. Claparede that the subsidence of so large an area as that of the supposed island would have caused a considerable refrigeration in the climate of the northern hemisphere, with a corresponding change of the fauna and flora of the Mediterranean region, which would have permanently engraved itself upon the memory of the Egyptians.

Notwithstanding the weight which at first glance would seem justly to attach to these objections, there are, it is claimed, many circumstances which, from an archæological standpoint at least, are strikingly consistent with the truth of the tradition, and which seem to indicate

America as the "continent beyond" whence "there was a passage for travelers of that day."

In the interpretation of the tradition, it might be said that we should allow something for oriental exaggeration and the imperfect knowledge of the ancient Egyptians respecting the relative dimensions of countries with which they supposed themselves familiar, and should therefore place little stress upon the traditional size of the island lying nearest their territory—if, indeed, the description: "larger than Lybia and Asia put together," were not in reality intended to apply to the *continent*, as would seem most natural. Upon the same principle, we may make allowance for the magnitude of the alleged cataclysm in which all trace of the islands and their inhabitants was lost, and suppose it to have been but the subsidence of some smaller islands, perhaps of a volcanic nature, by reason whereof communication with Egypt was cut off. The early navigators, as is well known, had not the means of accomplishing extended voyages in the open sea, except where a chain of islands enabled them to divide their journey into short stages, That this was the mode of intercourse between Egypt and the Atlantic continent, appears from the tradition itself; and we may easily understand how the accounts of such a subsidence, with the accompanying destruction of life, brought to Egypt by terrified mariners, would magnify the event into a terrible cataclysm, the recollection of which would effectually deter further exploration in that quarter for ages.

The reason assigned by the tradition for making no further efforts to ascertain the nature and extent of the alleged catastrophe, namely: that the sea, where the islands had formerly stood, was rendered impassable by great depths of mud, would seem to favor this interpretation, for volcanic scoriæ have been known to cover the sea for leagues in extent during and after eruptions, so as to impede navigation for a considerable period.

Again, if we examine the map of the Atlantic ocean we shall discover in the North Atlantic, stretching to the westward of Europe and North Africa, the outline of a vast island represented by the conventional marks designating a swamp or shoal. It is called the Sargasso sea, and is generally avoided by ships on account of the great quantity of sea-weed there collected. The depth of this sea varies from one thousand to ten thousand feet. The late Edward Forbes conceived that this weed first grew on an old coast line, since submerged, forming the western extremity of Europe and North Africa, and extending far into the Atlantic. Sir Charles Lyell, on the other hand, combats this view, and attributes the collection of sea weed in that locality solely to the action of ocean currents by which it is transported from the tropics.

Without presuming to determine whether in fact the Sargasso sea or shoal is a subsided island or an eddy of the ocean, it is sufficient for the purposes at hand to observe that in the spot designated by the Atlantic tradition, there exists and has existed for an indefinite period an impediment to navigation which may by fair intendment relieve the ancient Egyptians and Greeks of the geographical ignorance imputed to them.

Besides this tradition, however, there are other allusions to the Atlantic isles in the writings of Plato and other classic authors. According to Diodorus, the Gardens of the Hesperides and the Atlantic islands were the same, whereof the soil was fruitful, diversified with mountains and pleasant vales, and pleasure gardens planted with divers sorts of trees, and with towns adorned with stately buildings and banqueting houses in the midst of orchards.

The nebulous "Elysian Fields" were situated in the same favored spot. From these and kindred associations the name *Atlas* was itself derived—the personification of navigation and the conquest of the sea by mercantile enterprise. In classic mythology he was said to have descended from Ocean and married Hesperis, or the West, and from their union sprang the Atlantidæ, who inhabited the islands bearing their name. Homer calls him "one who knows all the depths of the sea" and "who keeps the pillars which hold Heaven and earth asunder"—in allusion to the "Pillars of Hercules," or, possibly, to the Atlas mountains on the west coast of Africa which, to the Egyptians and other early navigators of the Mediterranean, were a familiar sight upon the western horizon where the earth and sky met.

Ovid calls him "King of the remotest West"; rich in flocks and herds, and master of the tree bearing golden apples. Hesiod, also, speaks of Atlas as neighbor to the Hesperian nymphs. Antaeus, son of Atlas, who founded Tangier upon the African shore of the Straits of Gibraltar, is related to have sent abroad for assistance to resist the attacks of Hercules, and also to have received new strength from his parent as often as he touched the ground; which has been interpreted as alluding to maritime aids received from Atlas that became effective only when they reached the shore. The Cabiri, according to Sanchoniatho, held a tradition that Atlas was buried alive by his brothers, which may bear reference to the cataclysm mentioned by Plato.

Pliny states that there existed, even in his day, vestiges of an ancient population in the ruins of edifices on the Canary Islands; and Herodotus speaks of a tribe called Atlantes living on the west coast of Africa, whose modern descendants, the Berbers, are strongly distinguished from the surrounding tribes by their physical appearance and reddish complexion, and language analogous to that of the aboriginal population of the Canaries. Proclus, speaking of certain islands situated in the "outward sea," mentions the fact that the inhabitants of one of them—Poseidon—preserved a tradition handed down to them by their ancestors, of the Atlantic island of prodigious magnitude, which had really existed in those seas; and which, during a long period of time, governed all the islands in the Atlantic ocean, and refers to the Ethiopian history of Marcellus as authority for the statement. Other classic writers attribute to the kings of Atlantis a knowledge of astronomy and the invention of the sphere.

Without multiplying these citations, they tend to show, when taken in connection with the account obtained by Solon in Egypt, that there lingered among the Mediterranean nations, a tradition, more or less distinct, of islands lying in the Atlantic ocean at some far distant period, that were beautiful and fruitful as a garden; rich in flocks and herds; abounding in gold; governed by wise and powerful kings, acquainted with navigation and astronomy; and that after attempting and partially accomplishing the subjugation of the eastern continents, the inhabitants of those islands were, with their country, by convulsions of nature, engulfed in the sea and entirely destroyed; or, if we please, became lost to the knowledge of oriental nations by the subsidence of intermediate islands which had aided the primitive navigation of the time.

Assuming the physical possibility of the tradition being true in substance, we may proceed to briefly review the evidence upon which it is sought to apply the same to the continent of America, in referring our aboriginal civilization to a common source, or an intercourse with the Egyptians and other nations of the East.

The initial point for our consideration is presented by the word *Atlantis*, or *Atlas*, which gives name to the great ocean barrier separating the so called New World from the Old. This, we are told, has no satisfactory etymology in any European language. Anthon, it is true derives the word from *α* intensive, and *τλαω*, *to endure*—tracing it, evidently, to the mythological idea of Atlas supporting the heavens. This derivation, however, appears hardly reasonable, since the name would seem to have existed before the duty was imposed upon the god, and was no doubt imported into the Greek through maritime intercourse with the African nations. It is more probable that the original signification of Atlas—king of the Atlantic isles, situated far in the west beyond the Pillars of Hercules—was gradually lost, as commerce declined and the tradition of the existence of the islands became indistinct, and was ultimately merged in the secondary idea of "keeper of the pillars which hold heaven and earth asunder,"—which stood upon the western horizon where the eye would naturally turn in looking toward the fabled islands, and thus became crystallized in the mythology of the day. It is, therefore, more reasonable to suppose that the few greek words, and there are but few, which contain the radical *ατλ* or *τλ*, all of them involving the idea of supporting a burden, are themselves derived from this secondary signification of Atlas.

Accepting this, then, as an imported word, foreign to European language, the argument drawn from comparative philology proceeds upon a precedent established by Max Müller. This distinguished philologist traces the locality of Ophir mentioned in the Hebrew bible, in the following ingenious manner. Speaking of the fleet of Tharsish which Solomon had at sea together with the navy of Hiram, and which came once in three years bringing gold, ivory, silver, apes, and peacocks, also gold from Ophir, algum-trees, and precious stones, he says: "A great deal has been written to find out where Ophir really was; but there can be no doubt it was India. The names for *apes, peacocks, ivory* and *algum-trees* are foreign words in Hebrew, as much as *tobacco* or *gutta-percha* are in English. Now if we wished to know from what part of the world gutta-percha was first imported into England, we might conclude that it came from that country where the name *gutta-percha* formed part of the spoken language. If, therefore, we can find a language in which the names for peacocks, apes, ivory and algum-trees, which are foreign words in Hebrew, are indigenous, we may be certain that the country in which that language was spoken must be the Ophir of the Bible. That language is no other but Sanskrit;" and India, the learned author concludes, is the land of Ophir; and argues that the vessels of Solomon traded on the coast of Malabar and brought away the products floated down the Indus, a conclusion supported by other considerations as well.

If, therefore, to use the formula of Max Müller, we can find a country, in the spoken language of which the word *Atlantis* has an indigenous root, there it is said we are justified in seeking traces of the long lost race.

That language was spoken in the lovely vale of Anahuac, at the period of its conquest by the rapacious Spaniard; and tropical America, that land, rich in flocks and herds, beautiful as the Elysian fields, and so abundant in gold, it is hardly oriental hyperbole to say its trees bore golden apples.

"It is a tropical Switzerland," says a recent writer. "Flanked by two oceans, and rising from both to the rich plateaus of the table lands, Mexico possesses, on both acclivities, all the temperatures of the world, and ranges from the orange and plantain on the sea shore, to eternal ice on the precipices that overhang the higher valleys. Change of climate is attained merely by ascending, and in a region where the country rises steeply, the broad leaved aloe and feathery palm may be seen relieved against the everlasting snow of Popocatapetl. All these delightful climates produce the fruits and flowers of the tropics on the same parallel of latitude that crosses eternal frost; while over all, a never-ending spring bends its cloudless arch. Nor are these the only allurements of this wonderful land; for Nature, as if unsatisfied with pampering the tastes of man by crowding the surface of the earth with everything that might please his appetite or delight his eye, has veined its sterile mountains with precious ores in exhaustless quantity."

Here, too, we find the radical *tl* or *atl*, one of the commonest roots of the spoken language, entering into numerous words of varied signification, and also existing as a separate word, whose meaning is such as would render it the one most likely to be transmitted to foreign nations through maritime intercourse.

The primary signification of the word in the Nahuatl, or Toltecan, language, was *water*; from which were derived Atlan, *on the border* or *in the midst of water*; Atlaça, *to combat*, or, *to hurl or dart from the water*, with preterit Atlaz, and numerous other words of like form, containing the radical in combination.

But an argument drawn from a single philological coincidence, however strong, is hardly sufficient to satisfy a critical mind, unless confirmed by other analogies less general than beauty and fertility of the country, or its wealth in flocks or gold; for we may reasonably assume that an intercourse, however remote, between the primitive inhabitants of Egypt and America would have left some traces in the monuments, traditions and social systems of the latter, which would afford additional evidence of such communication. Besides, the Aztec races, in whose spoken language these words occur, were comparatively recent invaders of Mexico, and the *prima-facie* presumption would be that their language and customs were also imported, and that such analogies would, therefore, be wholly valueless as circumstantial proof. But, without digressing to answer this objection in detail, it may be said, generally, that those who have most carefully investigated the subject, including Baron Humboldt, agree that the Aztec civilization was founded upon the more elevated and refined systems of the earlier races whom these invaders supplanted, and that the civil and religious polity which they enjoyed was mainly the result of ages of growth among the nations who preceded them.

The case is not without familiar parallels in history, illustrating the vitality of civilization, especially when conquered amid the physical monuments of its culture. The survival of the fittest is shown in the history of our own tongue, and such may have been, by parity of reasoning, the fate of the early American language, which would have survived, in great measure, the destruction of all other attainments. To repeat, what seems an apt figure, the page presented to us by the Archæology of tropical America, must be regarded in the light of a palimpsest, which, beneath the rude characters inscribed by the Aztec, retains, nevertheless, the impress of a higher and more refined civilization. Viewing this culture, then, in its general aspects, eliminating those features evidently engrafted upon it by the barbarism of its conquerors, and regarding it as a creature of indigenous growth in the spot where it first became known to Europeans, it is claimed to possess characteristics so analogous to the ancient systems of the Mediterranean nations, as to offer legitimate ground for inferring communication at a period when the latter had long emerged from primitive conditions, and established well defined dogmas of culture and religious belief.

It is manifestly impossible within present limits to take more than a cursory view of these points of comparison.

The ancient Mexicans, like the Egyptians, are chiefly known to us through those enduring monuments which are the memorials of their former greatness. Scattered through the secluded valleys and crowning the picturesque heights of tropical America, are the moss-covered ruins of temples and palaces which excite the admiration and wonder of the beholder, at the proficiency in the arts of masonry and sculpture which they display. Such architectural ornamentation evidences "a long stage of unrecorded development." "In the monuments," says an eloquent essayist, "we have the human deposit of the ages—the truth of the historic past. Architecture, in this view, is the geology of humanity. Ceasing its testimony at the present surface of the globe, geology tells nothing of that subsequent history which commences with the existence of man; here architecture resumes the thread of the narrative and bears witness of that compound existence to which it owes its origin. That consecutiveness which is dimly descried in documents, in architecture is apparent; that human progress which all believe, but which so few show forth distinctly, is beautifully narrated in the monumental series."

In both Egypt and America the pyramid represents the highest attainment in architectural form. In both it is the prominent and pervading feature of the monumental remains. The American pyramidal structures, like those of Egypt, in most cases faced the cardinal points, and many of the temples and sacred places were alike surrounded by walls of earth or stone. The pyramids were often approached by elevated causeways, and the temples were located in the vicinity of water which was used in sacred services.

Concerning analogies traceable in mere architectural forms, Humboldt remarks that they "prove very little in favor of intercommunication between people, for, under all zones, men have indulged in rhythmic repetitions of the same forms." This remark is quoted by Brantz Mayer, and supplemented with an intimation that such forms are controlled by climatic or geological necessities rather than by art. If this be true, we should seek the origin of the pyramid, as developed in Mexico, in the volcanic character of a region where the largest base in proportion to height is required to resist the shock of earthquakes. But how will this avail us in tracing the same development in the valley of the Nile? If we are prepared to accept the conclusions of the Astronomer-Royal of Scotland (C. Piazzi Smith), ascribing to the great pyramid of Ghizeh the character of a great original, built by a different race from the Egyptians, and which served them as a model for their later and inferior structures, the solution of the problem is easy. He thinks it not improbable that the science fossilized in the great pyramid originated with a now extinct race, who inhabited islands once existing in the South-Atlantic Ocean, but makes no allusion to the Atlantic tradition.

While it may be true that evidence of analogy in mere architectural forms would be inadmissible—to use a legal phrase—as not of itself tending to prove an intercommunication between nations; yet, it is claimed, that when a foundation is laid by a distinct tradition of such communication, such evidence becomes not only admissible but highly important. And it may be remarked in connection, that Humboldt nowhere mentions the Atlantic tradition, and it does not appear that his attention ever was called to it. But it is not alone the mere coincidence of form that offers analogy in the architectural monuments of Egypt and America. Their general spirit and uses were in many cases identical. Modern investigations establish the well known form of three stages or terraces, surmounted by a temple, as common on both sides of the Atlantic.

In the general ideas of ornamentation, as delineated in sculpture, there may be likewise traced many striking coincidences. At Copan, on a stone obelisk were chiseled human figures with caps on their heads, sandals on their feet, with garments reaching half way down the thigh. On the tablets of an altar were sculptured sixteen human figures in low relief, sitting cross-legged upon cushions with fans in their hands. At the same place were colossal stone figures with heads of animals and bodies of men. All of these, it must be admitted, strongly suggest the Egyptian style, not only in the mode of presentation, but in the selection of subjects. Crouching figures of animals in the similitude of the Sphinx; human heads showing the Egyptian mode of head-dress with singular fidelity; serpents in conventional form, and numerous other works of minor importance, are cited as exhibiting such resemblances to Egyptian art.

But, before passing from the art remains to other features of the early American culture, one noble monument is worthy of remark, no less from the varied and graceful forms delineated in its exterior ornamentation—which are said to strongly resemble, and indeed, far surpass, many specimens of Etruscan art—than that in its elevation the pyramidal form is reversed.

The edifice at Mitla rests upon a solid pyramidal base or pedestal of brick, five feet in height, encased with slabs of dressed stone. From this base, the walls of the main structure incline outward and attain a height of twenty-five feet. The ground plan of these ruins resembles the Greek cross, and seems to have once included three other structures like the one which now remains, enclosing a square interior court paved with cement. Three of the interior walls of the existing edifice, covered with a hard and highly polished cement, contain horizontal recesses of sufficient size for the reception of a human body. Each wall contains nine of these compartments, arranged in three tiers. The exterior finish of the walls is also in three tiers or courses of stone, divided into rectangular panels, corresponding with the interior recesses, making, however, sixty-three panels in all in the exterior faces—the ground plan of the building being in the form of the letter T. The exterior stonework is of the most accurate character. Each of the sixty-three divisions or panels is a recess cut into the solid stone, and contains geometric figures in a mosaic of small blocks of stone, set in high relief in a mass of enduring cement, forming numerous designs of great beauty and regularity.

"The spectator," says Brantz Mayer, "who looks at one end of this singular building, * * might almost fancy that he stood in front of a gigantic sarcophagus, designed and sculptured in advanced periods of Grecian and Roman art."

Beneath the paved central area once enclosed by these edifices, are said to exist subterranean apartments, similarly ornamented by mosaics of stone. The entire structure, so far as we can judge by those remains which have survived the ages, was intended as a place of interment—a gigantic sarcophagus, at once suggestive of the rock sculptured tombs of the Egyptians, with ornamentation of Grecian art.

In intellectual culture, and in certain general features of social organization, the resemblances between the ancient nations, are claimed to be equally striking. In both Egypt and America the occupations of the people were designated in earliest infancy, and the education of youth moulded accordingly. While the "caste" distinction of Egypt was not so sharply defined among the Mexicans, yet priests, warriors, artizans, farmers, and traders, were, nevertheless, separated by defined limits. Among both nations the priestly classes were numerous and powerful, living apart from the community in convents, and were curators of learning, especially versed in astronomy, exercising an important influence in the administration of the state.

In the peculiar features of their religion and mythology, many points of resemblance are indicated as showing a transmission of religious ideas between the two nations, or, at least, a common origin of religious belief. Of these, only a few can be here mentioned. Similarly to the Mediterranean nations, the Mexicans believed in many deities presiding over special affairs of men; also in the existence of spirits inferior to the gods, who controlled minor concerns, and of whom each family had a number of images or penates, according to rank. Athor of the Egyptians, and Astarte of the Syrians, have their counterpart, it is claimed, in Tetevinan, "Mother of the Gods," in Mexican mythology. The tradition of Quetzal, is compared with that of Isis and Osiris, who first showed the Egyptians the use of wheat and barley, made implements of husbandry and taught their use, gave them laws, civil organization, marriage, and worship, and, finally, after teaching these arts, assembled a host, and went into all the world, conquering nations by music and eloquence. In the Mexican theogony, Quetzal was a great benefactor who came from the east, and after teaching the arts of peace and civilization, departed again to the far east in a vessel, promising one day to return—a promise which led the Mexicans to fall an easy prey to the covetous Spaniard whom they regarded as descended from their god. In the Mexican doctrines of the future life, there is also to be traced a general resemblance, to the Egyptian theories. Among both nations, the doctrine of the future state was well established, and closely connected with astronomy. Both believed in a partial transmigration of souls, and, therefore, bestowed but little care upon the dwellings of the living, which to them were temporary;

but upon the tombs of the dead, especially of the great, they bestowed great care and expense, as fitting for their permanent abodes. According to the Egyptian belief, after the soul finally departed from the body, it began its transmigration through inferior animals, lasting 3,000 years, when it again entered a human body. Among the Mexicans, a similar belief led to similar results. Religious works and tombs alone remain to attest the zeal of the builders. They held the immortality of the soul, and three places of abode therefor—the sun, wherein dwelt the spirits of nobles, soldiers killed in battle, and women dying in labor. (A similar belief was held by nearly all the Indian tribes in the vicinity of the Mexican Gulf.) The happy dwellers of the sun could after a time revisit the earth and animate clouds, birds, and animals, and revisit the sun at will. Those killed by lightning, disease, or drowning, went in spirit to a cool, shady place called Tlalocan, where feasts and pleasure awaited them. All others were at death consigned to Mictlantocli, kingdom of Mictlan, god of hell, a dark and gloomy place in the center of the earth.

In comparing the ancient astronomical culture of oriental and American nations, we enter upon a field of which but a passing glance must here suffice. This knowledge both Humboldt and Prescott assign the first rank as a distinguishing feature of the American aboriginal civilization, and both likewise frankly admit the difficulty of "considering, as the result of observations made by a nation of mountaineers in the uncultivated regions of the new continent." "They measured the length of the tropical year with a precision unknown to the philosophers of antiquity,"—says Prescott. The day with the American as with the Egyptian and many Asiatic nations, began at sunrise. The civil year was a solar year of 365 days divided into 18 months of twenty days each, and five complementary days. Besides the civil calendar, the priests made use of a lunar calendar by whose mysteries the festivals were regulated with great exactitude.

Thirteen of the Mexican years formed a cycle, four a "ligature," and two of the latter an "old age"—all of which (excepting the latter) were expressed by appropriate symbols. The half century of 52 years, was represented by a wheel surrounded by a serpent, with its tail in its mouth, and four knots signifying the four indictions or cycles. A similar symbol among the Egyptians indicated a century.

The names and hieroglyphics of the Mexican months, all relate to the festivals, public works, and climate of Mexico and nothing in their etymology indicates birth in a more northerly climate. Humboldt admitted the indigenous character of this branch of Mexican culture, so far as influenced by those purely Asiatic ideas by him attributed to the Aztec migrations.

In every 52 years, thirteen days were intercalated, which is the same in effect as the addition in the Julian calendar of 1 day every four years, and consequently fixes the length of the year at 365 days 6 hours.

The Persians intercalated 30 days in every 120 years; but the Chaldeans, Romans, and also the Syrians, who added one day every four years, all appear to have derived their solar year of 365 days 6 hours from the Egyptians. This analogy led M. Jouard to suppose the Mexicans also borrowed their measure from the Egyptians, or that both had a common origin. The same writer also shows that the sign of the "balance" existed in the Egyptian Zodiac long previous to the Roman conquest, and that the same sign is found among the sculptured antiquities at Elephanta, and also in the "lunar houses" of the Peruvians; and also mentions what he considers a significient fact, that Cipactli, the first sign of the days in the Mexican calendar corresponds with Capricorn the first sign of the Zodiac in the Egyptian designation.

R. G. Haliburton also finds from an exhaustive inquiry into the literature and traditions of primitive nations that there existed a common and universal system of chronology based upon the Pleiades—the year beginning on that night when the Pleiades are "above" or "are more distinct," that is to say: when they cross the meridian at midnight. The traces of this ancient knowledge, he finds in the various festivals and periodic customs of ancient peoples.

Among the Egyptians, the festival of Isia bore a singular resemblance to that of the cycle among the Mexicans. According to the Egyptian belief, when the sun descended toward Capricorn and the days gradually diminished they feared it was about to leave them forever, whereupon they put on mourning and the appearance of sadness. When the great luminary began to mount higher toward the zenith and the days were lengthened, they put on white robes and flowers amid great rejoicing. The Mexican festival took place on the five unassigned days of the year preceding the thirteen intercalary days during which they put on the appearance of deepest distress and fear. All household vessels and precious articles were broken, fires were extinguished, and the entire population gave themselves up to lamentation as if the end of the world were at hand. In the evening of the last day began the Festival of the New Fire. The priests followed by immense crowds ascended a sacred mountain, and there, when the Pleiades mounted to the zenith, the sacred fire was kindled in the pile whereon a human victim lay. As the flames ascended, joyful acclamations rent the air, repeated far and wide by watchers on housetops and teocallis, and the new fire was distributed from temple to temple by fleet messengers and thence to private dwellings. When the sun reappeared, the acclamations were renewed and the people, assured of a new lease of the earth for another cycle repaired to their homes to spend the intercalary days in renewing and purifying their households and in rejoicing and congratulation.

Concerning these singular customs Mr. Haliburton says: "We turn now to Mexico and there find that the great festival of the Mexican Cycle was held on the 17th of November, and was regulated by the Pleiades. It began at sunset, and at midnight as that constellation approached the zenith, a human victim was offered up to avert the dread calamity which they believed impended over the human race. This belief was so remarkable that I can not omit a reference to it here. They had a tradition that at that time the world had been previously destroyed, and they dreaded lest a similar catastrophe would at the end of a cycle annihilate the human race. Now it is most remarkable to find that the Egyptians with their Isia or new year's festival of agriculture, and of the dead, that took place on the 17th day of November, associated traditions as to the deluge." The subsequent confusion in computations of time, among the Egyptians he attributes to the later custom of observing the heliacal risings and settings of Sirius Sothis or the great Dog Star.

In summing up, Mr. Haliburton concludes that the Pleiades year, and probably the human race, too, originated in the isles of the Southern Ocean and spread thence by ship to more northerly regions. He traces the same festival and the Pleiades year among the ancient inhabitants of Persia, India, Egypt, Peru, Australia, Society Islands, Ceylon, Polynesia, and refers our observance of "Hallow-eve" to the same source.

Humboldt, on the other hand, attributes these analogies of religious belief and observances to the natural tendency of superstitious ideas among all nations to assume the same form at the rise and fall of civilization.

In thus stating some of the points wherein coincidences exist in the ancient American and oriental civilizations, which, in connection with the Atlantic tradition are claimed to establish a ground for inferring a communication at some very early period in the world's history, though much is omitted for the sake of brevity, enough is apparent to show that the subject is, in the present state of our knowledge, incapable of very definite discussion.

Investigators are by no means agreed as to the value of the evidences subject to examination. It must be admitted, however, that it is not easy to find a satisfactory reason for these analogies in the conditions of developmont of the two races; for in this view we might expect to find no greater resemblance than is common between other nations similarly situated. Common features may, it is true, be observed in the social and religious systems of many ancient peoples, and it might be said that these do not *per se* prove a community of origin. But the resemblances between the Mexican and Egyptian systems, it is claimed, are of a peculiar character, readily distinguishable from those common to other nations. The division of the people into castes; their special knowledge of astronomy; the erection of pyramids and temples for worship and sepulchre; belief in the transmigration of souls; together with many other striking resemblances in religion and arts, it is maintained, can hardly be referred to a coincidental development of races—one a race of mountaineers, isolated so far as we can ascertain, from all exterior influences by great ocean barriers; the other, residents of alluvial plains, in the immediate neighborhood of other and distinct races, possessing capacities for elevation which at an early day produced civilizations which awed the world.

A further fact is asserted by Brasseur de Bourbourg: that among the early Mexican nations, there was a lingering tradition of a great cataclysm, such as mentioned by Plato, in which many of their ancestors were destroyed by a great wave which rolled up from the Atlantic to the base of the mountains, overwhelming all within its reach. A violent subsidence of extensive areas of land, accompanied by earthquakes, ensued, of which the Bahama Islands, Greater and Lesser Antilles, and Carribbee Islands, are but the higher elevations projecting above the water. It is to be feared, that the enthusiastic Abbe, has stated the case too strongly. The reference to a deluge, is a tradition which the Aztecs possessed in common with nearly all the Indian tribes of North America, which many bibliologists have supposed to be a lingering remnant of the Semitic traditions, prevalent on the plains of Asia; and their traditions of an age of fire, and one of famine, to be, in like manner, a traditional reminiscence of the destruction of the "cities of the plain," and of the famine "which was upon all lands," when Joseph, the Israelite, served the Egyptian Pharaoh. Catlin says of the Mandan tribe, on the upper Missouri, that they held a yearly celebration in honor of the preservation of their great ancestor from the flood in a big canoe, a symbol of which was erected in the center of their village, and held in great veneration. It is difficult, sometimes. to ascertain just how far statements of this kind are tinged with the prejudices of the observers; and, the worthy Abbe having the Atlantic tradition in his mind, and the enthusiastic Indian artist feeling certain he was among the long lost tribes of Israel, may, both have unconsciously colored the facts to suit their respective theories.

In the assertion of Brasseur de Bourbourg, however, be true, it would seem to form the complement of the Atlantic tradition and complete a chain of circumstantial evidence of great strength.

The main argument against the tradition, namely: its alleged physical impossibility, is one upon which scientists are not agreed. Sir Charles Lyell treats it as a fact, so far as this is concerned, regarded by the people of that day as a judgment of their supreme deity. After citing the earthquakes of 1822, in South America, which the priests made use of to inveigh against the political revolutions in that country, he says: "In like manner in the account given to Solon by the Egyptian priests of the submersion of the islands of Atlantis under the waters of the ocean after repeated shocks of an earthquake, we find that the event happened when Jupiter had seen the moral depravity of the inhabitants." In this there is no hint of the want of probable truth in the tradition, which would have appeared, had the distinguished geologist considered it as a thing physically impossible.

Several authorities are cited by Brasseur de Bourbourg as supporting the opinion, that the eastern coast of Central America and Mexico once extended far to the eastward, and included the West India and Florida islands, and those lying to to southward as far as the Orinoco river. Among these are Moreau de Saint-Mery ("Description topographique et politique de la Partie Espagnole al'Isle de Saint-Domingue," 1796), who considers "the innumerable islands situated from the mouth of the Orinoco to the Bahama Channel (islands which include several Grenadins not always visible, in very high tides or great agitations of the sea), to be the tops of the most elevated of a chain of mountains which crowned a portion of the continent, whose submersion has produced the Gulf of Mexico." Mr. Charles Martins (Revue des Deux Mondes, March, 1867,) is also quoted as expressing the opinion, that "hydrography, geology and botany agree in teaching us that the Azores, the Canaries and Madeira are the remains of a great continent which formerly united Europe to North America.

Undoubtedly, to accept the theory of a cataclysm such as the tradition of Atlantis requires, we must greatly enlarge the commonly received theological view of man's antiquity. But the universal tendency of modern investigation is to prove the antiquity of the human race to be far greater than we can yet conceive. That America forms no exception to this statement is freely admitted by Bancroft, who also intimates his belief that there once existed in tropical America a much higher state of civilization which had temporarily deteriorated at the time of the Spanish conquest.

Without pursuing further the speculations which the tradition suggests, we may conclude by suggesting that while the Atlantic theory is not, in the present state of our knowledge "so preëminently well founded as to be generally accepted by scientific men," yet, in view of all the facts, no clue which has been offered, as leading to a satisfactory explanation of the aboriginal civilization of this continent, seems to promise more interesting results than this. While Professor Owen and other Egyptologists already trace the original Egyptian culture to a people far different from those known to us as Egyptians—a race closely resembling the Australian type—we recognise in our own archæology, also, the traces of a foreign influence, exerted at remote periods consistent at least with the explanation afforded by the Atlantic tradition.

How Ancient America Wrote. By G. Brühl, M. D.

Brilliant displays of force and courage dazzle more than the quiet and unobtrusive labors of the mind; the heroic deeds of great generals and the foundation of vast empires by victorious conquerors, excite more attention and admiration than the intellectual achievements of nations or the means by which these achievements are realized.

But of what importance toward the advancement of mankind are changes in the boundaries of states, or murderous wars which men wage against each other for the aggrandizement of wicked tyrants, in comparison with those actions of the mind, which calmly and peaceably foster arts and sciences, and pave the way to civilization?

Foremost among these mental labors ranks the invention and development of writing—that magic power which embodies and perpetuates the lofty thoughts of all countries and ages, that zealous agent which collects and treasures the fruits of intellect for present and future generations, that wonderful fountain from which streams of wisdom and learning flow. It is an historical fact, that no people destitute of written language has ever attained to a superior state of mental culture or even to an elaborate system of divine worship.

The development of this beautiful art, whose origin is involved in mystery, was surely not the act of a single moment nor the happy thought of one individual, but the toilsome and tedious work of many ages and innumerable minds. Rude and clumsy in the beginning, through perseverance and meditation it was wrought out to a more or less perfect system.

Leaving aside the efforts of the nations of the old world, let us trace the different methods by which the aborigines of this continent, unaided by foreign influence, succeeded in solving this difficult problem. It forms one of the most interesting chapters in the history of their civilization.

When the savage hunter of the dark forests of the north put each day a pebble in his moshkimut, to mark the days of absence from his dear ones; when the herdsman of the high plateaux of the Andes made knots in a string to record the number of his flocks, they were leading the way to the wampum and quippos, the former of which became the official notation of the Algonquins, the latter that of the children of the sun. When the proud warrior of the plains tattoed his totem on his breast, or painted his slain enemies, pierced with arrows, on his buffalo robe as a proof of his bravery, he practised the rudiments of that famous writing which received its final touch from the ingenious sons of Aztlan.

Why the American aborigines resorted to such poor and simple shifts for the transmission of thought, can be partly explained by the peculiarity of their language. The native dialects abound in figurative and paraphrastical expressions, thus furnishing readily the symbols for an ideographic notation. Moreover, their polysynthetic construction, uniting the leading idea with all its relations and modifications into one long polysyllabic word, at once formidable to the eye and ear, pointed in the same direction. How much labor and time did it save to the Blackfoot, when he could represent the moon, which he called Na-too-cou-cou-i with a cusped figure, or the war club (ma-ni-qua-pe-cac-sa-que) with its simple emblem? How convenient was it for the Ojibway, to denote a skull, which he terms Osh-tig-wa-nee-ge-gan, with a circle and a few dots, or for the Mohawk, the river, (Ka-ih-ogh-ho) with a waving line?

There is another peculiarity, or rather defect, in the native tongues, which had a remarkable influence on the mode of writing. Offering marvelous facilities, (to quote Dr. Brinton), for defining the perceptions of the senses with the utmost accuracy, but, regarding everything in the concrete, the native dialects are unfriendly to the nobler labors of the mind —to abstraction and generalization. For such a limited sphere of mental activity there is no need of a high-wrought system by which the most delicate shades of thought can be recorded. Philosophical treatises the Red man could not and would not write. What he did intend to chronicle—historical events and matters pertaining to government, religion and social life—could be portrayed with the simple means of wampum strings, knotted cords and pictographs, since these matters required merely the recording of concrete ideas in their totality without regard to the elementary parts of the sentence.

A brief description of these auxiliaries will best elucidate how they were rendered available. The wampum, employed chiefly by the northern tribes, consisted of beads of shells and colored bits of wood, pierced in the middle, and hung in such a manner as to form figures and characters. Each color, size, shape, and combination of strings, had its peculiar meaning. Brown and deep violet, which were the most valuable, portended something of serious import; white signified peace and kindness; red was the emblem of war, while a black belt gave warning of an approaching evil, or an earnest remonstrance; colored figures intermixed with the beads, expressed new ideas; a red belt, wrought with the figure of a hatchet in white, declared war; a black belt, with two hands joined in white, indicated peace. Besides the strings were used to keep an account of time, and to record events they were given in the delivery of speeches and messages, and at the execution of treaties, to recall the chief articles of the transaction. These public documents, says Loskiel, are carefully preserved in a chest made for this purpose. At certain seasons, the tribes meet to study their meaning, and renew the ideas of which they are an emblem and confirmation; and as it is the custom to admit even the young boys, who are related to the chief, to these assemblies, they become early acquainted with all the affairs of the state, and thus the contents of their documents are transmitted to posterity and cannot easily be forgotten.

Besides these belts, various simpler mnemonic aids were employed, such as strings of pebbles and fruit stones, and circular slabs, engraved with characters. The Indians of North Carolina and the Assiniboins, used parcels of reeds of different length and marked with notches. In memorizing their lessons, the children in the public schools of Mexico availed themselves of belts of coral. The ancient Carans, of Quito, were accustomed to perpetuate the memory of important events by a significant juxtaposition of small pieces of wood, clay, and stones, of various sizes, colors and forms, which were kept in their temples, palaces and tombs.* Analagous to the wampum belts are the knotted cords or quippos, mainly in use with the southern tribes. They were known to the Chibchas, Cocomucos, Araucanians,

* Hassaurek. "Four Years in South America." p. 361. Also see Bollaert.

and probably to the Mexicans, whose symbols of numeration seem to have been derived from this source. Certainly they were known to the neighbors of the Mexicans, the Tlascalans (under the name of Nepohualtzitzin), to the Chilenians (as pron), and to the ancient Purahas long before their subjugation by the Incas. Under the government of these princes, they became the sole official notation within the empire of Tavantinsuya. The poet Ylyia, a favorite of the fourth Inca, Mayta Capac (1126-1156), is credited with having reduced them to an elaborate system.* Composed of a number of woolen strings or threads of different size and color, variously knotted, and intertwined and fastened to a large base cord, who would not wonder that such poor contrivances could be rendered profitable as a means of record? Still they served admirably this purpose, by allotting to each color, and to the modes of intertwining the knots or of twisting the pendant strings a particular signification. Even the succession of the threads and the distance of the knots from the junction of the thread with the mother cord varied the meaning. Red indicated war or soldiers; the yellow, gold; the white, silver or peace; the green, maize (cereals). Applied to numerals, a single knot meant ten; two single knots, twenty; a knot doubly intertwined, one hundred; triply, one thousand. The chief objects were always designated by the first thread, the least important by the last. If the quippo treated of the inhabitants, the first string alluded to the age over sixty, the second to those over fifty, and the last to the infants; if it treated of crops, the threads referred successively to maize, wheat, peas, beans, and millet; if of arms, to lances, arrows, bows, javelins, war clubs, hatchets, and slings.

Thus this simple arrangement of knots and intertwinings, though probably serving at first the mere purpose of numeration, became in the course of time by an ingenious application to the various conditions, phases and relations of life and government, a valuable substitute for written documents and annals, and answered for the registering of laws and decrees, of taxes and tributes, of marriages, deaths and births, of armies and supplies, and for the chronicling of historical events and statistical facts, yea even of religious ceremonies, festivals and sacrifices. As biographical sketches, the quippos were buried with the dead, and in our day numbers of them are still exhumed from the huacas.

But it was necessary for the reader to know two things in order to interpret these mysterious memorials. Either signs had to be at-

* H. Wuttke. "Origin of Writing," p. 181.

tached at the commencement of the base cord, or, when coming from a distant province, a verbal commentary had to be sent with the messenger explanatory of the subject matter of which they treated. The office of knotting, deciphering and preserving these public documents was entrusted to the Quippocamayocs, of which each village of any note had at least one. In order to avoid any confounding or mixing, all quippos belonging to the same class were placed in separate repositories. To guard against interpolation or forgery, a special board of supervisors was appointed to watch the keepers. Another class of officials, the Amautas, were charged to give instruction in reading and knotting the cords, and to relate annually at the festivals the historical events of the empire to the assembled people.

Judge how much such an intricate system, intelligible only to the most skillful and learned, served the policy of the Incas, whose favorite maxim was, that science was not intended for the masses! As long as the quippos were the sole treasuries of learning, these rulers had nothing to fear from progress and enlightenment, those dangerous foes of despotic authority. With the overthrow of the Inca rule, the more high-wrought system of knotted cords gradually perished. Only in their simpler form, for the purpose of numeration, they remained in force. The converted Indians employed them as a mnemonic aid in their confessions. At the haciendas and cattle stations of the Puna they serve the herdsmen, even nowadays, in making lists of their various flocks. Tschudi thinks, however, that in the southern provinces there are still Indians who know well how to decipher them, but guard their knowledge as a sacred secret. Yet some of the earlier Peruvian historians have succeeded in collecting the materials for their works from these mysterious records.

All attempts made in our day to read them have proved futile. Neither do we know which notion is attached to each knot, nor have we the verbal commentary to explain the subject matter of the document. For curiosity's sake it may be mentioned, that the Prince of San Severino, a member of the Academy of La Crusca, in a pamphlet published in Naples, called forth by the "Peruvian Letters" of Madame Gravigny, seeks to prove that the knots had an alphabetical value, and even describes the grammar and dictionary of the cords. But not a single reason sustains such a bold theory.

Prior to the official sanction of the quippos by the Incas, pictorial writing, though of the rudest kind, seems to have been the current method of notation amongst the Peruvians. This opinion rests on more reliable authority than Montesino's, who states that during the reign of the third sovereign (according to his list of 101) the use of letters was known and the Amautas taught the art of writing on leaves of the plantain, but that under Titu Yupanqui, the 64th sovereign, civil disturbances caused the loss of letters, and that the 78th sovereign prohibited his people from making use of the quillca, substituting the knotted cords instead.* There are still many of the pictographic relics extant. Tschudi discovered, in the ruins of a building near Huari, a stone tablet with hieroglyphic inscriptions, and the walls of the palace of Macao are similarly ornamented. Rivero found, near Arequipa and Huaytaca engravings in granite representing animals, flowers and fortifications; Bollaert saw pintados in the peninsula of Copakakava, (near Tarapaca) and in the Pampa del Leon, and refers to a large stone pillar, between Mendoza and La Punta, 150 feet high, called the "giant," which contains certain marks or inscriptions resembling Chinese characters. He also mentions another one near the Diamond river, called by the Spaniards "Stone of St Thomas," containing the impression of a man's feet, together with the figures of several animals, and some marks which appear to be ciphers or characters. Raymond has copied several other engravings found near the sea coast.

The mystic characters over the monolithic door of the magnificent building of Tiaguanacu, and on the head of a statue found in its ruins† seem to belong to the same class. Vollmer gives a description of a hieroglyphic painting, representing, in his opinion, the transmutation of matter from its primitive state into man.

But what is of even greater interest, vestiges of hieroglyphic inscriptions on portable material have been discovered. I will only mention a lama skin, found near Lake Titicaca, and preserved in the museum of La Paz; a piece of cloth, dug from an ancient Huaca, near Ancon, by Dr. Plongeon; several sacred vases, and a chuspa, all covered with mystic figures.‡

That so far no specimens painted on paper have been found, seems to verify Montesino's statement, that after the introduction of the quippos, all the manuscripts were destroyed. At all events, the relics cited above, even without the positive testimony of Acosta, clearly demonstrate that the children of Tavantinsuya, were familiar with picture writing. There is equally sufficient proof, that this art was practised by other nations of South America. Narcissus Gilbar, a missionary amongst the Panos, on the banks of the Ucayale, found in the Pampas of Sacramento, manuscripts with hieroglyphic characters,

* Bollaert, "Researches" page 217.

† "L'Univers Pittoresque," Bolivie, 1843.

‡ Bollaert "Researches," p. 219.

containing, as the Indians said, the wanderings and sufferings of their ancestors, and such hidden things as no stranger ought to know. In the interior, beginning at the eighth degree of north latitude and extending over a waste territory of 750 miles in every direction, hieroglyphic inscriptions, cut into prominent rocks on the banks of the large rivers, or into the isolated granite blocks of the plains, are quite abundant. They ornament the high cliffs of the Orinoco, Rupunuri, Essequibo, and Amazon, and cover the face of nearly every rock on the falls of the Messai and Enganes: they are found on the head waters of the Rio Branco, and on the extensive plain bounded by the Orinoco, Atapasco, Negro, and Casiquiari. They are met by the tourist in Guiana, Venezuela and New Grenada.

These hieroglyphics represent signs of the sun and moon, houses, implements, and collossal, ill-shaped, human figures, bipeds and quadrupeds. The outlines are rude and imperfect: mere dots and lines indicate the organs of the senses and the extremities, and three convergent lines the fingers and toes. Proportion is never observed: sometimes the figures are enclosed in rectangles, and interspersed with curves and spirals.

Their obliterated condition speaks for their great age. The one, however, seen by Sir Robt. Schomburgh, on the Isle of Pedro, in the Rio Negro, representing, aside from 13 human figures, two Spanish gallions, must be, of course, of later origin than the commencement of the XVI century.

Some attribute them to the Guarari tribes; others, like Humboldt, consider them as remnants of an ancient civilization. Yet it is a remarkable phenomenon, that the figures on the vases, drinking cups, oars, and even the hieroglyphic signs which the hunter tribes in our day paint on the posts of their huts, have a striking resemblance to the rock engravings, and that the tent doors are adorned with the same monstrous heads and spirals enclosed in squares, as look down from the cliffs of the rivers. Hence, the remark of Martens' seems, justified, that the civilization of the engravers, though undoubtedly older, was not superior to that of the present inhabitants, who approach the pictured rocks with awe and fear, unable to decipher the sacred Tehmehri, or to tell their origin.

More correct and elegant in form and style are the inscriptions found in western Veraguas, once inhabited by the ancient Dorachos. The monuments and relics of this tribe are adorned with pictures of natural objects and fantastic characters. The Piedra pintal at Calvera, a few leagues from the capital of Chiriqui is a fine specimen, every part of which is covered with figures; one represents a radiant sun, followed by a series of variously formed heads, scorpions, and fantastic emblems. The top and the sides show signs of a circular and oval form crossed by lines. Several columns are seen in the town of David, the characters on which differ from those of the Piedra pintal by being raised and are considerably smaller. *

Of a similar character are the delineations found on the rocks in the mountains of Urnan, though the assertion of Fray Ramon Bueno, that they represent phonetic signs, is a mere hypothesis lacking all proof. More appropriately this could be said of the rock engravings on the Waraputa river, copied by Sir Robt. H. Schomburgh in his "Travels in Guiana and on the Orinoco."

In the northern part of our continent the inscriptions are as equally numerous as in the South. Wuttke, in his work on the "Origin of Writing," has collected a complete list of these Muzzinabics. We find them in the Pacific, Middle and Eastern states where the Dighton rock is their last outpost, along the shores of Lake Erie, and as high up as the straits of Michilimackinac. The figures, either representative or fantastical, often of gigantic size, are engraved or painted, many of them well preserved, others nearly effaced. A great number are perfect in shape and color, the various parts of the body are clearly defined, thus excluding the idea that they are mere freaks of nature or accident. Others are rude and imperfect in outline. The conformity of style and design points to a common origin, while the diversity in execution assigns them to different eras. Some, representing objects like firearms and garments, known only to the Indians after the arrival of the Europeans, undoubtedly belong to the post-Columbian era.

The inscriptions in New Mexico are strangely different from those of the northern latitudes. Instead of the free and plain juxtaposition of the principal figures, the lines have a mathematical stiffness and regularity, and the frequent repetition of parallel zigzag points and alphabet-like characters, gives them a resemblance to those of Central and South America.

Although the key for deciphering these mute epitaphs of vanished generations is entirely lost, their prominent position renders it evident that they were designed to commemorate important events. They mark the earliest period of pictorial writing. In later times, matters of minor import were cut on less conspicuous material, such as trees and posts. The native mind did not, however, stop with immovable inscriptions, but sought for means to render the information portable, to circulate it in public, and preserve it in families and tribes. For this purpose, smooth bowlders, wooden tablets, flat bones, pieces ot

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* Bollaert "Researches," page 30.

dress, blankets, robes, deer skins, shields, and birch-bark were chosen.* Thus, step by step, we can trace the transition from immovable to portable material chosen for notation.

Just as easily can we follow the development of pictorial writing itself through its different stages. But, prior to starting on this tour of investigation, let us ask what fundamental principles governed the pictographic notation? In the earliest stages, it was a mere portrayal of known facts and events by representative delineations of visible objects. The desire to awaken new ideas, or chronicle abstract notions (spiritual matters), suggested the necessity of investing the figures with an allegoric meaning, or expressing the idea with such a figure from the material world as had a logical relation to it, by way of cause, quality or effect. The picture of a deer recalls the ideas, not simply of a particular kind of quadruped, but, also of a swift, graceful animal, whose flesh makes a delicate dish, and whose skin is suitable for dress and robes. The figure of a deer answers, therefore, very well for swiftness or gracefulness. The signs over the doors of our shops are based on the same principle. If we see a half filled bottle, painted on the windows of a tavern, we know that something stronger than water can be had within.

Favored by the metaphorical nature of language, and accustomed to uniform associations of ideas, it was for the native mind neither difficult to find the proper representative images nor to interpret their correct meaning. Frequent use of and comparison between the various emblems employed, led to a uniform adoption of the most judicious and expressive.

But there are ideas which have neither a direct nor a symbolical relation to any visible object. For such cases arbitrary signs seem to have been invented, at least there is no other explanation left, whereever the relation between idea and symbol is obscure. Why the figure of the sun signifies watchfulness, a bow with an arrow war, a bone with a feather the power to fly, or even air, is a matter of easy guessing, since the relation between idea and symbol is apparent; but why in the Ojibway scrolls, which have more than two hundred of these symbols, a simple circle means spirit, a circle with transverse lines means water, or a horned snake life, can be explained only by the hypothesis that they are conventional emblems, since the logical relation between idea and symbol is purely fanciful.

In regard to the form of the figures, the desire for saving time and space led to abbreviations and simplifications. The Indian mind, gifted with extremely acute senses, was able to recognize from a few

* A fine specimen, painted on a buffalo robe, formerly belonging to a Sioux chief, and said to contain the history of his tribe, is in the possession of Judge Force, of our city.

outlines their real meaning. Hence for the whole figure only the prominent parts or characteristic features were depicted—for a turtle only its feet; for a deer only the head; a heart or triangle with a circle for a man. Painted headless, a human figure indicated death; the proper name was placed above, the totem beneath it. Again by moulding the partial figures together, new fantastical symbols for correlative notions were formed.

The relation of the various figures to each other was indicated by straight connecting lines, the close of a sentence by a few vertical dashes or strokes. This kind of notation, the Kekeewin, was understood by all tribes from Hudson's Bay to the Gulf, although each one had its own symbols, and Heckewelder remarks that they could as easily read a pictograph as we can a letter. The Iroquis are said to have surpassed the other nations in the more skillful handling of the pencil, while the Dacotahs painted the rudest figures. No wonder; it would be a paradox if it were otherwise.

Aside from the Kekeewin there existed a sacred pictography, the Kekeenowin, but, like the hieratic hieroglyphics of the Egyptians, intelligible only to the initiated. It was employed by the Medas and Jessokeeds of the Algonquins and Dacotahs at the recitation of their magic songs and ceremonies, each verse, pause and gesticulation having its own conventional symbol to which a supernatural power was ascribed. The symbols served merely as a mnemonic aid. The sorcerer had to know by heart the text of the song; since the mystic figures did not in the least suggest their hidden meaning.

Poor and defective as these means of notation were, they mark at least the advancement from a mere figurative to an ideographic writing, which acquired the highest development in the didactic painting of Tula. The restless and wandering life of the hunter tribes left no leisure for more favorable results. When a people has settled down, when the building of cities has divided labor and formed social classes, when the mollifying influence of agriculture has softened manners, when the wants and necessities of life have increased, when ideas and language have been enriched, and arts and sciences encouraged, then the enlarged sphere of mental activity calls urgently for an improved form of notation. We might then expect that the exiles of old Tlapalan, after having founded a new seat of a rich civilization, would refine the pictographic system, which they had brought along, to a high degree of perfection. As early as the seventh century, Huematzin, one of their savants, composed in pictorial characters the sacred Amoxtli, containing the sum of their knowledge and doctrines, their travels, institutions, rituals and legends. Later, Quetzalcoatl, the

Mexican culture hero, collected in the book of the sun (Tonalomatl) their historical records, traditions, laws and astrological fancies.

The Aztecs, successors and heirs to the arts and learning of the founders of Tula, inherited also their method of writing. Confined at first only to the priests, it was under the rule of the Montezumas taught in the academies and promulgated amongst the masses. Thus it came into constant use in the daily transactions of life, the figures being painted on slates of soft stone, from which they could be readily erased with wet sponges or cloth. The vases and monuments, the columns and walls of the temples and palaces, were adorned with pictorial inscriptions and the archives stored with painted volumes. A coarse, thick paper *(mazatl)*, like the Egyptian papyrus, was manufactured from the leaves of the *maguay* and *ikzotl*, or pieces of silk or cotton, covered with rosin for writing purposes. These sheets, from 12 to 15 inches wide and 50 to 60 feet long, were folded in a zigzag manner, and the outer leaves fastened to wooden tablets, giving them the appearance of a quarto volume, called in the Aztec tongue, *amatl.**

Surpassed only by the fanaticism of the Moors, who burnt the Egyptian papyrus rolls to kindle their camp-fires, the christianizing zeal of the Conquistadores has nearly destroyed all these precious documents. There are, however, a sufficient number preserved (now in the libraries of Berlin, Dresden, the Escurial, Vienna, Velletri, Rome, Bologna and Mexico), to give us an insight into the pictorial art and the dexterity of the Mexican scribes.

In minutely examining these manuscripts, we discover large figures, either single or in groups, and small colored delineations, together with fantastic signs, the latter both inclosed in rectangles. The mystic signs either surround the large figures, not unlike marginal annotations, or are interposed between the smaller delineations, or placed side by side in regular rows.

The shape of the figures, whether representing living or lifeless objects, is mostly bizarre, hard and angular, without the least regard to elegance or correctness, though more expressive than in the pictographs of the northern tribes. The essential parts are monstrously exaggerated, not unlike those in our carricatures, the heads thick and overgrown, the noses unnaturally long, the bodies dwarfish and misshapen, and the faces in profile, with the eyes in the center, showing conclusively that they were subservient to some other purpose than mere delineation. Many of the figures can be readily recognized as imitations of natural objects, while others appear arbitrary and ob-

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* Brinton, "Myths," p. 10, etc. H. Wuttke, "Entstehung der Schrift," p. 198, etc.

scure. Nevertheless, it is more than probable that their fundamental types were originally taken from nature, but altered in their course through various and curious modifications into unintelligible characters.

The important researches of Dr. Allen, reported in the *Proceedings of the Am. Phil. Soc.* (page 34), seem to throw a new light on this subject. The learned investigator has illustrated this process of change by means of various types (the crotaloid curve, rattlesnake, human face, etc.), reduced in one direction to their linear elements and in the other developed into bizarre combinations.

It is obvious that such a complete system could not be, like the Kekeewin, deciphered by mere ingenuity, though it was based on the same fundamental principles. The idea in its totality was recorded by groups of corresponding pictures, either representative or symbolical, painted in full or in part, or sketched by a few hasty outlines, without regard to the elementary parts of the sentence. For minor details and precise definitions, determinative signs were added or particular coloring resorted to. For instance, the dead were represented as having the feet wrapped up; the living, by small tongues near the mouth, and by having their feet at liberty. Males were painted reddish brown, and females yellow. Spaniards were portrayed with red dresses, blood with red, undulating lines.

To the class of determinative signs the characters for the higher numerals undoubtedly belonged. While the units were indicated by dots or circles, the signs for the higher numbers were as arbitrary as those in the Arabic system. A flag signified 20, crossed by a line 10; a feather meant 400, and a bag of cocoa beans 8,000. The intervening numerals were represented by corresponding divisions of the fundamental figure. Thus, 8,217 was written by two dots, three fourths of a flag, half of a feather and a bag of cocoa.*

The arithmetical signs once fixed, it remained to find appropriate symbols for the computation of time. This purpose was attained in two ways. The names of the months being similar in sound to either material or immaterial objects, in the one case the real, in the other the symbolical figure of the object was chosen as a suitable hieroglyph. A reed, called *agat,* became the emblem for the month *Acatl;* a house (*kali*) for the month *Kalli*; a skull for the month *Miquiztly* (meaning death); an arrow head for *Tecpatl* (flint). In a like manner figures of natural objects were selected to express such abstract notions as had homophonous names. Thus *momoztla* (daily) was depicted by two altars, pronounced *momoztli.* The same rule applied to the rep-

* Gama, p. 130.

resentation of proper names led a step further. Being generally borrowed from objects that strike the senses, from productions of the soil or the occupation of the inhabitants, and composed of several words, they were dissected into their radicals and the emblems of these united to one pictograph. Thus the city of Tenochtitlan (place of fishermen) was represented by an arm holding a fish; Ixtcoatl, the emperor, by a serpent pierced by obsidian knives. Did no type exist, the full phonetic value of which corresponded exactly with that of the syllable, they selected one, whose initial sound at least was analogous to it. For instance Moquauhzoma had as device a mousetrap (*montli*), an eagle (*quauhtli*), a lacet (*zo*) and a hand (*maitl*). Aubin has collected 104 of such syllabic characters, which used to be attached to the heads of the sovereigns, to indicate their respective names. As it often happens that a single vowel forms a syllable, like the *o* in Teokaltitlan, it was easy to designate every one of them by a fixed pictograph; thus *a* by that of water (*atl*), *e* by that of the bean (*etl*), *i* of the eye (*ixtli,*) and *o* of the track or road (*otli*).

In doing this, the Aztecs had gradually mastered the whole series of hieroglyphs. To render their system as perfect as the Egyptian, it was merely required to complete the phonetic variety and to make a more liberal use of it than heretofore. While the children of the Nile relied chiefly on phonetic characters, the sons of Anahuac clung more to the figurative. Considering, however, their .marvelous progress in the brief space of a few centuries, we may justly conclude, that, had they not been disturbed by the Spanish invaders, they would have likewise advanced to the top of the scale.

The contemplative mind of the Mayas, the Grecians of this continent, seems not alone to have reached this climax of the pictorial art, but even to have broken down the thin barrier that divides it from the alphabet. Indeed the monumental inscriptions in the palaces of Palenque, and in the ancient buildings of Chiapa, Yucatan and Guatemala are strikingly different from the Aztec pictographs. In the former the large figures have more the looks of ornamental than didactic painting, and the mystic signs, only sparingly met with in the Aztec manuscripts, decidedly predominate.

It will not do, as some have attempted, to explain this peculiar difference by the mere heterogeneousness of the material upon which the characters are painted or engraved. This might account for the greater or lesser elegance of execution and correctness of form, but not for the predominance of the significant signs. The frequent occurrence of the latter in different combinations, their arrangement in groups, and the constant repetition of the same dots, lines and circles, favor rather the supposition, as expressed by Landa that these, mystic signs are truly phonetic characters. The eminent archæologist, Brasseur de Bourbourg, has lately discovered, in the library of the Royal Historical Society of Madrid, the manuscript of the learned Bishop, which contains, aside from a description of the country, the Maya alphabet, consisting of 27 letters, and several syllabic characters, with a somewhat obscure explanation of their use.

The deciphering of the inscriptions in question, even with the aid of this alphabet, is, however, no easy task, because of the polysynthetic construction of the Maya tongue, which renders it necessary for the interpreter to resolve each group of characters into its elementary parts, and rearrange them in proper succession. This analytical process is the more difficult, as the sense of beauty has allowed the letters to be irregularly combined, and even to be changed from their original type, by adorning them with spirals and flourishes, so as to render them often unintelligible. Add to this, that our knowledge of the Maya idiom is very limited, that the grammars and dictionaries are very imcomplete, and the number of preserved manuscripts very small,* and we should neither expect a ready interpretation, nor be surprised that the attempt of Brasseur, tainted as it is by his prejudiced theories, is more a matter of curiosity than a success.

His countryman, De Chareney, however, was so fortunate as to spell out a few of the mysterious characters over the Cross of Palenque. May it prove the Rosetta-stone for unriddling the numerous inscriptions which ornament the walls and columns of the ancient temples of Central America! The publication of the manuscript dictionary, in the Smithsonian Institute, containing a complete vocabulary of the Maya language, would essentially assist in such a meritorious task, and would shed a flood of new light upon the dark history of that land of wonders. This hope, of course, will not be realized, if the opinion, advanced by some learned linguists—that the Maya alphabet was only invented after the introduction of the Spanish letters—is correct. But this opinion is hardly credible. If such were the case, why does not Landa state the fact? Why have the Mexicans not been favored by Spanish influence with an equal invention? Moreover, the Maya alphabet, and the method of using it, differs so totally from that of any other nation, that we cannot help considering it their own. And last, but not least, the deciphering of

* The only ones that have escaped the destructive zeal of the Spanish monks, are the one at Dresden, to be found in "Kingsborough's Mexican Antiquities;" that of "Troana," printed by the French Government, under Brasseur's supervision; the "Mexican manuscript No. 2," of the Imperial Library; and, perhaps, that of "Pesth."

the inscriptions in Palenque, engraved long before the arrival of the Castilian adventurers, proves, beyond doubt, its indigenous origin.

But, thus much is true: that the Maya notation was not purely alphabetical, but a mixture of both alphabetical and figurative; "for aside from the letters," says Landa, "they employed figures, and signs within the figures," the latter, of course, as syllabic characters. But what is of the greatest import, this notation enabled the writer to convey, literally, a full sentence.

It remains to add a few words regarding the order in which the figures and characters were placed by the painter. According to Clavigero, he was at liberty to commence at any corner, but he had to follow the same direction throughout the page, from top to bottom or from bottom to top, from right to left, or vice versa. Did he choose to write bustrophedically, then the custom was to begin from the lower left corner, continuing to the right, thence in the next higher line to the left, and so on.

The contents of the pictographic manuscripts embraced both divine and mundane subjects. They treated of theology, dogmas, rituals, festivals, historical events, public affairs, legal proceedings, tributes, geographical, statistical and educational matters. They were collected in libraries, temples and royal palaces. Academies and colleges were established for recording the annals and giving instruction in reading and writing. The sovereigns were the benign guardians and protectors of these institutions. That was the golden era of aboriginal civilization. It vanished with the downfall of the Montezumas. The rude hand of the conqueror destroyed its blossoms. European letters supplanted the native pictographs. It is true that Charles the V., because of the legal documents being recorded in the ancient characters, established a chair of didactic painting in the university of the Capital. But since none of the wise professors have left a syllable on the principles of this intricate art, the Amalthes will remain a sealed book to us, until another Champollion detects the magic key that unlocks its hidden treasures. What problem is unsoluble to science?

Teneina of the United States. By V. T. Chambers, Covington, Ky.

In the July number, 1874, of this Journal, I have published a review of a paper by Prof. Frey and Mr. J. Boll, on some American *Teneina.* It was hastily, and somewhat carelessly written, it having been my intention to remodel it before offering it for publication. It was, however, published without having been read over after it was first written, and, as I had no opportunity to correct the proof, it appears full of verbal inaccuracies and misprints, most of which, however, are evidently typographical errors. Most of these were corrected in the next number of the Journal, but a few others were detected after the corrections were made. The paper also contains some personal allusions, which had, perhaps, better been omitted (as being out of place in scientific controversy, although, unfortunately, that is usually the place where they are found), and would, no doubt, have been eliminated if I had bestowed more attention upon getting the paper in proper condition for publication. How these things came about, it is not necessary to dwell upon. And, if my criticisms upon Prof. Frey's work were too severe, I can only plead the strength of the temptation in extenuation; for certainly, I have never seen an entomological paper so provocative of criticism, and so full of errors, mistakes and confusion. It betrays (or, at least, I was at first inclined to think so) unmistakable evidences of the grossest carelessness in ascertaining whether his species had not been before made known, and in identifying them so far as they were known, combined with complaints of the defective character of the work of American laborers in the same field. But, after most thorough and careful study of the Professor's papers, I am convinced that his errors and mistakes arise more from a defective knowledge of the English language, than from carelessness. And now, after another careful study of the Professor's paper, I wish to offer the following remarks on some of his species. Many of the Professor's errors, I am satisfied, could not have been committed had he given to the papers of Dr. Clemens, and the writer the same, amount of careful study, with a competent knowledge of the English language that I have given to his pamphlet.

Gracilaria superbifrontella—(Clem.)

This species, is no doubt, rightly identified by Prof. Frey; but, almost certainly, Mr. Boll gave him incorrect information as to the food-plant of the larva. Mr. B. thought the larva fed on oak leaves, which is almost certainly an error, if the species is *superbifrontella*. Dr. Clemens bred it from the witch-hazel (*Hamamelis Virginiea*), and it has never been (so far as I have been able to ascertain), bred from any thing else in this country; and, it is exceedingly improbable, that a species of this genus feeds on two plants so remote from each other as the hamamelis and oak. Prof. Frey gives an account of the way in which the mined leaves, gathered by Mr. Boll, were jumbled together, and, no doubt, the error arose in this way. Besides, it frequently happened, that the Professor was unable to tell which of three or four kinds of leaves his species came from (as in the case of his *G. elegantella*, and other species), and in, at least, one instance, *Lithocolletis gemmea*, where the food plant is given as if it were known. I shall show, presently, that he was mistaken, in all probability.

G. elegantella—(Frey).

I have already *loc. cit.* stated that this is a synonym for *G. packardella*, Cham. Prof. Frey, says that it may be from American oaks, or it may be from the maple (*Aer. sacchainum*). I have long known the larva on the maple, and last fall succeeded in breeding *G. packardella* from it. The mine is linear and short, and the larva soon leaves it to feed on the under side of the leaf, curled down so as to make almost an elongate cone, with a diameter a little greater in one direction than in the other, and truncate near the top.

G. mirabilis—(Frey).

This is certainly *Parectopa robiniella*, Clem., which I had already referred to *Gracilaria*. Had Prof. Frey, with an adequate knowledge of English, examined carefully Dr. Clemens' description of *P. robiniella* he could not have failed to recognize it. In the paper in the last July number, before referred to, I did not recognize *P. robiniella* in Prof. Frey's account of *mirabilis*. I have now no doubt whatever of their identity. Professor Frey had given *Parectopa robiniella* (?) Clem., as a synonym for *Lithocolletis gemmea*, Frey, and being misled thereby and not fully understanding Prof. Frey's description of *L. gemmea*, I believed them to be the same, and so treated them in my review of Prof. Frey's paper. Now after more careful study, I am prepared to say that in *L. mirabilis*, Prof. Frey has given a good description of *P. robiniella*, and that an insect which meets the requirements of his *L. gemmea*, can not be *P. robiniella*, Clem., nor anything like it. I have been unable to recognize any Teneid known to me in *L. gemmea*, which is no doubt a new species. But Prof. Frey is, I am satisfied, in error when he says that it is a leaf-miner of the locust. Four insects are known to mine locust leaves in this country. They are *Lithocolletis robiniella*, Clem., *L. ornatella*, Cham., *Parectopa robiniella.*, Clem., and the beetle *Hispa Suturalis*, Say. They are all abundant whereever I have sought for them, and in this locality they are seriously damaging the locust trees. Owing to their ravages (mainly however, to the beetle which feeds on the leaves, both in the condition of larva and imago), locust groves by midsummer, look parched and dry as if a fire had swept over them. Only the three above mentioned lepidopterous mines are known on these trees. So Prof. Frey found only the same three in his leaves; and he bred *L. ornatella* and *L. robiniella*, from two of them. Why should he not have bred the third, *P. robiniella?* he did no doubt, and he has described it well as *G. mirabilis*, but not at all in his account of *L. gemmea*. He thus describes the three mines which he found in locust leaves: "A common *Lithocolletis* dwelling, with smooth border in which the larva is transformed," and in which we recognize the mine of *L. robiniella*, Clem.; also "an upper and under side mine of rounded not much serrated shape" and which is certainly that of *L. ornatella*; and also a "digitated upper side mine," which, omitting color, is as acurate a description of the mine of *P. robiniella*, as could be given. Now, as there is no doubt about any of these mines nor in this country, as to the insects which make them; and no other locust leaf miners have ever been heard of; as Prof. Frey had *L. robiniella;* and its mine; and *L. ornatella* and its mine; and had the mine of *P. robiniella*; and as *G. mirabilis* is a good description of *P. robiniella*, an *L. gemmea* is no description of it at all; then considering the mixed nature of the collection of leaves, it is a safe conclusion that *L. gemmea*, was not bred from mines in locust leaves. I proceed to show wherein *L. gemmea*, Frey, differs from *P. robiniella*, Clem. The tuft of the vertex in *L. gemmea*, is said, by Prof. Frey, to be more developed than in *L. ornatella;* in *P. robiniella*, in perfectly fresh specimens, it is as smooth as in a *Phyllocnistis*. In older specimens and those which have got their scales rumpled more or less, the scales of the vertex become roughened so that Dr. Clemens, described it as tufted. In *L. gemmea* "the forewings are bright saffron" but (compared with *ornatella*), "the darkening at the base is wanting;" in *P. robiniella*, the wings are dark brown, *P. robiniella* has no massing of gold scales on the fold, nor any "pale golden band straight and inwardly dark margined near the basal third of the wing," nor any band at all except the costal streaks crossing the apical part of the wing as in *G. mirabilis*. In short the description of *L. gemmea*, does not correspond with that of *P. robiniella*, in more than one or two particulars, *e. g.*, the white tips of the antennæ, in which it resembles *G. mirabilis.* If Prof. Frey had understood Dr. Clemens' clear, and acurate description of *P. robiniella*, he never could have made the mistake of confounding it with *L. gemmea*, even doubtfully, and had I not been misled by that identification, I should have detected the difference much sooner. Prof. Frey was probably led into the mistake, not by the resemblance of the insects, but by the supposed fact that *L. gemmea*, came from locust leaves from which he already had *L. robiniella*, and *L. ornatella* and the only other lepidopterous mine known was "the digitate mine of the upper surface," which is inhabited as is well known by the larva of *P. robiniella.* Some specimens of *L. ornatella*, are much less dark at the base of the wing than others, some are brighter, some darker golden, and sometimes the second fascia is found slightly interupted in the middle; but of the hundreds that I have seen, none had the tips of the antennæ white, and but for this I should consider *L. gemmea* as being much nearer to *L. ornatella* than to *P. robiniella. P. robiniella* is decidedly larger than *L. ornatella.* In addition to the reasons that I have elsewhere given for placing *P. robiniella* in *Gracilaria* is the position of the insect in repose.

Lithocolletis quercitorum—(Frey).

In the former paper I referred this to *L. Fitchella*, Clem. There seem minute differences between *Fitchella* and *quercitorum* as described by Frey. If not the same, they are very nearly so; an inspection of authentic specimens of each would determine. Besides *Fitchella* there is no other known American species which has the large dorsal white spot on the forewings as described in *quercitorum.*

L. longestriata—(Frey).

Identified doubtfully by Frey with *L. argentifimbriella* is no doubt that species. Dr. Clemens states that the antennæ are anulate with dark fuscus, but the annulations are very indistinct in all my specimens. Neither Dr. Clemens, nor Prof. Frey, mention that the apical joint of the antennæ is fuscus, but it is so.

L. alinella (?)—(Frey).

Prof. Frey, supposes that it came from alder leaves, because it so nearly resembles the European species. But that is by no means a necessary conclusion. No alder leaf miner has yet been found in this country. But that does not prove that none exist.

L. intermedia—(FREY).

Is very near *L. celtisella*, Cham., if I rightly understand Frey's description. It may be the same, but I think it is not. If Prof. Frey, is correct in the belief that it mines oak leaves, then it is new, as no oak leaf *Lithocolletis* of that group is known in this country.

L. consimilella—(FREY).

In the former paper, I suggested that this might prove to be identical with *L. tritæniaella*, Cham., which is the only American species hitherto known in this country, which has the fascia on the forewings, all internally dark-margined; but the markings behind the third fascia seem to be different from *tritæniaella*.

L. scudderella—(FREY).

This is certainly a redescription of *L. salicifoliella*, Clem. & Cham., though I did not recognize it at the time the former paper was prepared. I have discussed it more fully in a paper now in the hands of the editor of the *Canadian Entomologist*.

L. ignota—(FREY)

Or rather the form which Frey describes as the male (?) of it under the name of *L. Bostonica* is I think *L. hilianthivorella*, Cham., though the ground color of the wings in *hilianthivorella* is rather darker than I understand it to be in *Bostonica*. Only an examination of authentic specimens can determine it accurately. *Hilianthivorella* is very near *L. ambrosiærella*, Cham., and is perhaps properly considered only as a variety of it.

Jupiter sometimes nods. Considering the rank of Prof. Frey in Europe, as a Lepidopterist, it might look presumptious in me to characterise his work as I have done; but it so happens that he has been dealing in a manner altogether unworthy of his reputation, with a few species with which I am especially familiar. And when an authority like Prof. Frey, does bad work it only calls for severer criticism.

Cosmoptery.

I have sometimes thought that European Micro-lepidopterists generally, allow scarcely "ample room and verge enough" for variation within the limits of species, and that some of their species are perhaps only varieties. Usually, when specimens are bred from different food plants, or where there are small differences of larval habits, a mark or two, more or less, in the imago is usually considered sufficient to found a new species upon. Examples of this may be found in most of the little leaf-mining genera as *Nepticula*, *Lithocolletis*, *Phyllocnistis Tischeria* and in *Butalis* and others. This impression has been made upon me not by inspection of specimens of European species (for the number of these that I have seen is not great) but by a study of the writings of European Micro-lepidopterists. Therefore I may be wrong, and an inspection of specimens of some species, the validity of which I have been inclined to doubt, might convince me that my doubts were unreasonable. Following what I conceive to be the example of these Micro-lepidopterists, I have sometimes described as distinct species, insects as to which great doubt existed in my own mind whether they should be so treated Some of our species of *Lithocolletis*, *Phyllocnistis*, *Aspidisca*, *Butalis* and others, I regard as only doubtfully entitled to specific value, though I doubt not they would be regarded as distinct by most Micro-lepidopterists of Europe, because certainly 'species' do pass current there which are no more distinctly separate than those as to which I entertain doubts as above stated. Some American species which have been described in Europe as distinct, I am fully satisfied are not so. And as to the species mentioned and described below I certainly entertain doubts. If *Cosmopteryx orichalcea* is distinct from *C. hierochloœ*, and *C. Clemensella* from *C. gemmiferella*, then the species here described as *C. pulchrimella* is entitled to specific rank. But Dr. Clemens did not consider *clemensella* and *gemmiferella* distinct when he sent them to Mr. Stainton; and as to *orichalcea* and *hierochloœ* Mr. Stainton writes: "specimens of *C. orichalcea* do occur with the apical streak interrupted, and when that is the case I am quite unable to point out how the insect can be distinguished from *C. hierochloœ*" (*St. ed. Clem.* p. 100, and *Nat. His. Tin*, v. 12, p. 24.) I submit that the difference thus indicated is not of specific value even if it were constant.

However, it is the old question what constitutes a species, as to which every naturalist has his own 'notions'; about which *non est disputandum*. For myself, I am much inclined to consider *orichalcea* and *hierochloœ* as synonyms; and *gemmiferella*, *Clemensella*, and the insect described below, as belonging to the same species.

C. pulchrimella, n. sp. (?).

Rich dark brown, with a faint greenish tinge, not discernible in all lights. (Dr. Clemens says that *gemmiferella* is 'dark greenish-brown," and Mr. Stainton says, of *Clemensella*, that it is darker than *gemmiferella*. Something—much, no doubt, in such matters—is to be allowed for "the personal equation.") Substituting "rich dark brown with a faint greenish tinge," for "dark greenish-brown," the following portion of Dr. Clemens description, is applicable to this insect: "labial palpi, dark greenish brown, with a silvery stripe on the front of the third joint, and another behind, continued to the second joint; face, head and thorax, dark greenish-brown, with a narrow central silvery line continued to the thorax, and one of the same here above the eyes on each side." In this species, however, the white lines on the palpi extend the entire length of both joints, and the white line is not found on the face, and is but very indistinct, if it exist at all, on the vertex. Dr. Clemens further says, that "the antennæ are dark greenish-brown, with two silvery lines on the basal joint, the stalk annulate with silvery rings, and a broad silvery ring before the tip, which is likewise silvery." In this species, I have not been able to detect any annulations on the antennæ, though each joint of the basal half has a white line beneath, and instead of the "broad silvery ring before the apex, which is likewise silvery," there are three silvery annulations beyond the middle, the first two of which are closer together than they are to the third, and there are two others before the tip, which is of the general hue, and not silvery. As Mr. Stainton points out no difference between *gemmiferella* and *Clemensella*, other than those of the forewings, the presumption is that it does not differ otherwise. Dr. Clemens' description proceeds: "Forewings, dark greenish-brown to the middle, and from the apical third, to the tip, with an orange colored patch, rather beyond the middle of the wing, extended across the wing, and a little produced along the costa behind, having a large, transverse oval smooth patch of elevated silvery scales; somewhat violet-hued on the internal margin, the patch extending nearly across the wings; another, smaller and similar, nearly round one behind it on the inner margin, and another small one on the costa, behind the produced portion, with a white costal streak above it in the cilia. All these patches are somewhat black margined. Near the base of the wing are three short silvery streaks, one nearly on the disc, one near the fold beneath it, and an oblique one above it near the costa. The cilia of the extreme apex is silvery white, black margined above, with a violet silvery scale in the middle of the wing before the tip. The inner margin, at the base of the wings, is silvery." Mr. Stainton (*loc. cit., page* 25 *in note*) corrects his description, as follows: "Anterior wings dark greenish-brown, with three short longitudinal silvery streaks *near the base*, with a *reddish*-orange fascia, edged with silvery violet in the middle (*this fascia is considerably broadest on the costa, its hinder margin being formed by two silvery violet spots, which are by no means opposite*); at the apex is a short silvery white scale, preceded by a violet silvery spot, *with which it is not connected.*" And of *Clemensella*, Mr. Stainton writes: "The ground color of the anterior wing is darker, (than in *gemmiferella*), the orange fascia is paler, not so reddish, its margins are pale golden, instead of silvery violet, and its hind margin is almost straight, and thus, very different from *gemmiferella;* finally, the apical streak is continuous, not interupted, and of a silvery white throughout." In the specimen before me (*pulchrimella*), the thorax and forewings are rich dark-brown, tinged with green; the silvery white streak on the thorax is interupted, and, as in Dr. Clemens' description, it extends on to the base of the forewings; at about the basal fourth of the wing length, are the three silvery streaks showing a violaceous hue in some lights, the one nearest the costa begining a little before the others and oblique, and there is another minute one on the extreme base of the costa; at the middle of the wing length is the silvery fascia, which does not quite touch the extreme costa, though the intervening space is almost inappreciable. In some lights, this fascia looks like burnished steel, in others it exhibits pale golden reflections; its margins are straight and parallel, anteriorly it has a narrow margin of dark scales, from the dorsal margin to beyond the middle; posteriorly, the the costal portion, only, is dark margined; at about the apical fourth of the wing length, is an oblique fascia of the same hue, with the first mentioned fascia nearest the base on the dorsal margin, and extending to a white spot in the beginning of the costal cilia, and very narrowly margined before by dark brown scales. In the space between these two fascia, Mr. Stainton and Dr. Clemens locate their 'orange,' or 'reddish-orange' fascia. But, if by 'orange,' or 'reddish-orange,' is meant anything like the orange, reddish-orange or golden fascia of *C. Schmidiella*, *Orichalcea* and *Lienegiella*, as figured in *Nat. His. Tin.*, *vol.* 12, then *pulcherimella* is something quite distinct; for, on first observation, the difference between the color of this part of the wing, and that before the first fascia, is not likely to be observed; on closer observation, however, it will be seen that there is a paler hue, what might be called an orange-brown, or, in some lights, bronzed, extending entirely across the wing adjacent to the first fascia, but narrowing backwards almost to a point on the costa at the second fascia, but much more distinct towards the costa. In some lights, the whole space between the two fascia, shows the orange-brown hue, but, in such lights, the wing before the fascia exhibits nearly the same hue. There are, also, four or five minute, violet, silver specks in the space between the fascia. Behind the oblique fascia, the wing is darker brown, with an oblong, violet, silver spot at the base of the dorsal cilia, and another at the apex, passing into the snow-white apical cilia. The cilia are, otherwise, dark brown. The under surface of the thorax and abdomen, and the basal joints of the anterior legs, are silvery or pale golden, or like burnished steel, according to the light. Anterior tibiæ and tarsi, dark brown before, silvery white behind; posterior and middle legs, dark brown, with the tibiæ and tarsi annulate with silvery white, and a silvery white streak on the posterior tibiæ behind. *Als. ex.* scant, 4 lines. Taken at Covington, Ky., May 22, in a season, at least, two weeks later than usual.

It is the only specimen of the genus that I have taken in six years of active collecting.

Glyphipteryx.

Of this genus as of *Cosmopteryx* six years of diligent collecting has yielded but a single specimen of a single species and it was taken at the same time and place with the *Cosmopteryx* (*supra*) viz.: Linden Grove Cemetery, where more than nine-tenths of my Kentucky Micros have been taken, and at a time when I had given up all hope of finding there anything new. At the same time and place I found a new species of *Gracilaria.* Whilst this locality produces an abundance of species of most genera, a few genera seem almost unrepresented. As for instance I have taken here but a single specimen of *Anaphora*, whilst near Mammoth Cave I find several species, and took more specimens of that genus than of all others put together during the two weeks in July that I spent there.

G. exoptatella, n. sp.

This insect was taken at the same time and place with the above described *Cosmopteryx* and like it is the only specimen of the genus that I have met with here, and therefore comes like one born out of due time and none the less welcome. It is so near *impigritella*, Clem., that before I gave it a close examination I took it to be a specimen of that species. But Dr. Clemens says that the first (the large curved silvery dorsal streak is dark margined on both sides in *impigritella*, whilst in this specimen its margins are no darker than all of the basal portion of the wing, except close to its apex, from which they pass backwards along the middle of the wing for a short distance, but in some lights they are not visible at all. The form and position of this streak are almost exactly as in *Haworthana* but it is more slender and pointed. In *impigritella* the forewings are said to be dark bronzy brown slightly touched with golden brown between the costal streaks; in this specimen the basal part of the wing and the thorax and head are dull leaden brown, with faint bronzy reflections in some lights, and passing about the middle into golden brown which covers the apical half of the wing though in some lights portions of it appear dark brown. There are five costal streaks placed as in *impigritella* and *equitella* 2, 1, 2 and (as in *impigritella*) all these streaks are decidedly dark margined internally; but these dark margins do not extend across the wing as in *impigritella*, nor do the dark margins of the first and second streaks meet; the extreme costal margin is dark brown from the base to the tip, except where it is interupted by the costal streaks. Dr. Clemens says that the 'costal and dorsal streaks in *impigritella* are silvery white, and that the violet-silvery' spots are absent. In this insect the costal streaks are all white but are tipped with violaceous metallic scales, and the second and third are especially so; the first is oblique decidedly, the second less so, and the others are perpendicular to the margin; opposite the points of the first and second costal streaks is a dorsal white streak placed as in *impigritella*, but ending in a violet metallic spot; the second costal streak—metallic violet, as in *equitella*—points towards but does not quite attain a violet metallic spot within the dorsal margin, which is not mentioned in the account of *impigritella*, but which in *Haworthana* is represented by the *second* of the *metallic* spots; and in *equitella* by the first one that is the longitudinal or oblique dash, (not by the spots which in those species the second costal streak nearly or quite touches,) it is immediately opposite the third costal streak; with careful manipulation there may be observed a minute violet metallic point opposite to the fourth costal streak and just within the dorsal margin; the last dorsal and last costal streaks are opposite and both are white tipped with violet metallic scales and are slightly curved and almost meet so as to form a fascia concave towards the apex. The apical patch is velvety dark brown, the cilia of the dorsal margin and apex are greyish silvery with a wide fuscus band covering their base. Unfortunately though the insect is perfect in every other respect, the costal cilia are injured so that I can not tell whether the costal ciliary dark line of the other species is present or not. The palpi are white with a dark brown line beneath as in *Haworthana* Antennæ dark brown, legs and tarsi dark brown, the tarsi annulate with white, and the middle pair yellowish within; venter silvery white, the anal tuft a little tinged with yellow. *Al. ex.* $\frac{3}{8}$ inch. Kentucky.

As with the *Cosmopteryx*, I hardly know whether this insect represents a new species, or is only a variety of some described one. The ornamentation is almost equally like *Haworthana*, *equitella* and *impigritella*.

LITHOCOLLETIS—*L. Rileyella*, n. sp.

This is the nearest and only near ally of *L. argintinotella*, Clem., yet made known in this country. It is indeed exceedingly close to it, but it is darker saffron, has six instead of five costal streaks, which are (as are also the four dorsal streaks) all dark margined internally and are all very distinct, whilst in *argintinotella*, the fourth and fifth are small and sometimes obsolete, and the antennæ instead of being silvery white, are dark ocherous, with brown annulations. As in *argintinotella* the face and palpi are white, the vetex yellowish and white, and the thorax and forewings are golden saffron. On each side of the thorax just above the patagia, is a snow-white line continuous with the rather wide and distinct snow-white median basal streak of the forewings; which extends beyond the basal fourth and is unmargined. The first costal streak is very oblique opposite the basal position of the first dorsal streak, and is continued very distinctly along the costa to the base, and after it leaves the costa is very faintly, dark margined above. The second costal is less oblique, the third is still less so, the fourth is a hook almost (or quite?); meeting the apex of the third dorsal, the fifth is a short line pointing obliquely forward, and the sixth is a small spot close to the apex, and just beyond the minute black circular apical spot; the first dorsal streak is like that of *argintinotella*, but is somewhat wider; it is placed about the basal third, is wide upon the costa curving back along the middle of the wing to a point near the apical third, and like all the other costal and dorsal streaks, it is strongly dark margined, internally its dark margin produced backwards along the middle of the wing till it joins the dark margin of the second dorsal streak, which is distinct triangular with its dark margin produced beyond it; the first dorsal streak recalls the similar streak in *Glyphipteryx exoptatella* and *G. Haworthana*, but is wider on the base. The third dorsal as above stated is opposite to, and almost confluent with the fourth costal streak; the fourth dorsal is small and opposite to the minute apical spot: cilia yellowish with a brownish wider marginal line on the base. Abdomen and tuft yellow: hind legs yellowish silvery with the outer surface of the tarsi dark brown. Described from two specimens, received from Prof. Riley and Miss Murtfeldt, from St. Louis, one captured, the other, labeled "tentiform mine on under surface of red oak leaves," *al. ex.* of one, $\frac{1}{4}$ inch, the other $\frac{1}{3}$ inch.

LAVERNA—*L. Murtfeldtella*, n. sp.

A single captured specimen received by me, from Prof. Riley and Miss Murtfeldt, in perfect condition, seems nearer to *L. propinquella* than any other species known to me, but the resemblance is not very close. Form of palpi nearly as in *L. ochracella*, Ins. Brit., Vol. 3. It has the head and palpi silvery white, the second palpial joint brown on the outer surface, and the third dusted with brown beneath, the antennæ are dark brown. Anterior wings brown, faintly streaked or marbled with ocherous. There is an oval white spot on the base of the dorsal margin, running lengthwise along the margin, but wide enough to reach the fold; a little further back is a white dorsal spot partly grizzled by brown scales, and connected with the first spot by a faint ocherous line along the fold, the wing between these white spots and the costal margin is brown faintly streaked with ocherous, and from the second spot to the costa, in some lights, is indistinctly suffused with grayish; just behind the middle of the wing is a nearly semi-circular ocherous line convex towards the dorsal margin, the hinder part of this line or narrow band is more distinct than the anterior portion and contains or rather is interupted by a short white longitudinal dash, placed near the end of the cilia; a little further back is an irregular ocherous spot, containing a short longitudinal brown dash, followed by a white one, or by some white scales, the space between the black dash and the first white one is brown: in some lights, suffused with hoary, and on the extreme costa just before the cilia is a small hoary spot indistinctly connected with the whitish scales behind the black dash; behind this the wing is brown with three minute white costal streaks in the cilia and one longer slightly oblique apical one, all of which are only visible in certain directions; costal and apical cilia brown, dorsal cilia silvery gray. The thorax is white with a pale purplish fuscus spot in front, the legs are silvery yellowish behind, and brown in front annulate with white. Abdomen brown above, silvery beneath with the tuft yellowish silvery.

GELECHIA—*G. Discoocella*—CHAM.

From an examination of a single specimen given to me by Prof. Riley and Miss Murtfeldt, I find that the two specimens, from which the description was prepared, are a little worn. In the perfect specimen, the so-called ocherous streaks within the inner margin are not present, except in the fold; the discal brown spot not so easily distinguishable from the surrounding hue; and the ochreous spots around the apex are each margined behind with blackish, or more properly, there are a series of minute black spots margined before with ocherous scales; the thorax, though paler than the wings, is rather brown, tinged with ocherous, than simply ocherous; the antennæ are rather robust, and somewhat serrated toward the apex. In this specimen, the central brown dot in the spot at the end of the cell, is connected with the surrounding brown, not an 'island' as in my two specimens. Nevertheless, I have no doubt, it is the same species. The *al. ex.* is $\frac{9}{16}$ths inch, whilst, in my specimens, it is $\frac{1}{16}$th inch more, This specimen, is labeled, by Miss Murtfeldt, "Leaf folder of a small weed." A perfectly fresh glossy specimen is one of our prettiest species of the genus.

G. physalivorella, n. sp.

A very different thing from *G. physaliella*, Cham., though labeled, by Miss Murtfeldt, "from physalis." It rather resembles, in ornamentation, *G. ambrosiœlla*, Cham., though the ornamentation of the wings is, perhaps, even more like that of *Tischeria heliopsisella*, though sufficiently distinct from it, also. *Second joint of the palpi with spreading scales, almost brushlike, and not twice as long as the third.* The forewings are ocherous, mottled with brown spots, connected with each other by longitudinal and oblique brown streaks; in the costal half of the wing, and running nearly parallel to the costa are three black lines, in a line with each other, but not connected; the first and shortest is before the middle, the second and longest begins about the middle, and the third is before the apex; cilia of both wings ocherous-gray, hindwing of a leaden ocherous hue. Abdomen yellow, the anal tuft suffused with pale-reddish; head and thorax, dark shining-brown; antennæ brown, faintly annulate with ocherous, with the extreme tip ocherous, and six distinct ocherous annulations before the tip; second joint of palpi, ocherous and brown, mixed, third joint brown, with extreme tip, and an annulous before the middle, ocherous. *Al. ex.* $\frac{1}{2}$ inch. From Prof. Riley and Miss Murtfeldt, from Missouri.

G. simpliciella, n. sp.

Pale grayish, slightly tinged with ocherous. There is a small blackish discal spot about the middle of the wing, with four or five very small and indistinct ones before it, and two or three nearly in a line behind it. *Second joint of the palpi but little thickened toward the* *apex; third pointed, about half as long as second.* *Al. ex.* little over ½ inch, Kentucky. Has some resemblance to a worn specimen of *G. Solaniella,* but it is quite distinct and more decidedly gray.

G. inæquepulvella, n. sp. (?)

I am not certain that this of which I have received a single slightly worn specimen from Miss Murtfeldt, should be described as a distinct species, I think, however, that it is distinct. The wings are much paler than in *Solaniella* though this may be in part due to the fact that they are a little rubbed, but there is in *Solaniella* to which this approaches most closely no appreciable difference in color between the general surface of the primaries and the cilia, except that the latter are darker, the ocherous color being absent though the white cilia are present. On the contrary in this species the cilia are sordid very pale yellowish with two faint brown hinder marginal lines near their apex and in this species the head and palpi are creamy white. *Al. ex.* three-eighths inch. Hab. Missouri. *G. parvipulvella,* Cham., from Texas is also very near this species but is but little dusted.

G. Marmorella, n. sp.

Palpi slender, third joint as long as second; pale gray marbled irregularly with dark brown, with no salient markings. *Al. ex.* three-eighths inch. Difficult to distinguish from *G. discomaculella* even on comparison of specimens. But *discomaculella* has a tolerably distinct though pale fascia just before the cilia, and also before the fascia a large costal and opposite dorsal patch which almost meet behind the middle of the wing. Hab. Kentucky.

G. ambrosiæella, n. sp.

Palpi scarcely attaining the vertex. Second joint brush-like; third joint thickened and about half as long as the second. It is white suffused over the greater portion of the body and wings with ocherous yellow, and the fore wings marbled with dark brown streaks and spots which are confluent, and especially noticeable abont the middle of the costal half of the wing. The antennæ have the basal three-fourths ocherous annulate with brown; the apical fourth has five series of joints each having the first joints black and the third one white, but at the apex the penultimate joint is black and the terminal one white. The palpi are ocherous faintly sprinkled with brown and the third joint has a brown annulus at the base and another about the middle. Vertex, thorax and forewings whitish suffused with ocherous, the forewings marbled as above stated and with an irregular brown spot in the apical part, the basal and dorsal portions however are but little marked with brown: under surface of body, and the legs, pale ocherous, the first pair of legs being distinctly marked with dark brown on the basal joints and but faintly so on the others, except the tarsi which are annulate with dark brown; the intermediate and posterior legs are but faintly marked with dark brown. *Al. ex.* $\frac{7}{16}$ inch. Kentucky.

The larva feeds in September and October inside of the seed capsules of the 'hog weed' (*Ambrosia trifida*). It, while small, severs the capsule at its base, and eats into it at that point. I have also bred from the same gathering a beautiful little moth, belonging to the *Tortricidæ,* and I am not certain that I have seen the *Gelechia* larva when it was very young, as I am inclined to refer all of the very small larvæ to the *Tortrix.* The smallest *Gelechia* larvæ were already more than one-fourth grown; they are then pale green with the head and shield a little darker green; the next two segments have each a transverse row of six greenish fuscus spots on top and another spot on each side. The remaining segments have each two spots on each side, and on top are two transverse lines or bands of the same greenish fuscus hue, the hinder band scalloped near each end, both before and behind. But it is probable that the color and arrangement of the marks varies with each moult, as the larva in its last stage has the head pale fungineous with the other segments, yellowish white, and the transverse bands and spots almost obsolete, and very pale dusky green, while two longitudinal pale reddish lines extend along the back on, all the segments except the head. In the breeding jar the larva leaves the capsule to pupate, and passes the pupa state among the decaying bracts and small leaves; but frequently like the larvæ of *G. Hermanella,* and some other species it eats its way into the pith of corn stalks or into pieces of cork or other soft substances, and mixes the comminuted particles with its cocoon.

On page 222, *vol.* 6, of the Canadian Entomologist, Miss Murtfeldt has mentioned an undescribed species as *G. chambersella* and has obligingly favored me with a specimen. It is quite distinct from *G. ambrosiæella* though allied to it, and though feeding on a species of *Ambrosia* it feeds on the leaves and not on the seed. *G. ambrosiæella* is more distinctly marked then Miss Murtfeldt's species, and the wings are clouded with fuscus spots and patches. Some specimens emerge in October and November, some pass the winter the pupa and some in the larva states.

There is also a coleopterous larva which feeds on the seeds of *A. trifida* eating a large hole in the sides of the capsule. I have not yet succeeded in rearing it.

G. cristatella, n. sp.

Palpi over arching the vertex with the second joint clavate, the scales at its apex somewhat spreading; third joint almost acicular more than half as long as the second, second joint of the palpi brown dusted with white, and white along the upper surface; third joint white with a brown annulus before the middle and another before the tip; tongue and a narrow stripe above it, extending along the inner margin of the eyes dark brown; head white; thorax dark brown sprinkled with white along the margins, the anterior margins entirely white, and with a small raised tuft just before the apex. Antennae annulate with white and dark brown, forewings at the base dark brown mixed with white and with a distinct tuft on the fold margining the dark brown basal portion behind; then follows an oblique white costal streak crossing the fold and interrupted on the fold; behind this another dark brown band crosses the middle of the wing, margined behind by two raised tufts, one of which is above; and the other beneath the fold, and followed by a transverse band of mixed white and brown, which is margined in part behind, by a brown tuft within the dorsal margin nearly opposite the begining of the cilia, behind which the apical part of the wing is brown sprinkled with white, except a short slightly curved dorsal white streak at the begining of the cilia, and a similar larger opposite costal streak. The legs are marked alternately with white and brown or grayish brown spots and bands; the under surface of the thorax is white dusted with brown, the white of the thorax and legs having a metallic hue. Its external appearance is that of a *Laverna*, but the wings are those of a *Gelechia*. Except that the second joint of the palpi is simple, it resembles the species which I have placed in *Adrasteia*. But those species shade into *Gelechia* so that I am now satisfied that *Adrasteia*, can not be mentioned as a distinct genus. *Al. ex.* ½ inch, Kentucky. A very pretty species.

HYALE—*gen. nov.*

Head depressed clothed with appressed scales, vertex wider than long; face strongly retreating; eyes moderate; antennæ slender about half as long as the wings distinctly ciliated; basal joint small; tongue rather short, scaled; no visible maxillary palpi; labial palpi recurved, divergent, over arching the vertex, simple; the third joint more than half as long as the second, and accuminate similar to those of many species of *Gelechia*. Wings broad; with rather short short ciliæ. The forewings in outline and neuration nearly those of *Strobisia iridipenella*, Clem., widest about the middle and with the apex obtusely rounded; the costal vein runs near the subcostal for about half its length and then rather suddenly diverges, attaining the margin about the middle; the subcostal subdivides into five nearly equidistant branches of which the first arises before the middle and the last attains the apex; the median subdivides about the end of the cell into three equi-distant branches of which the first arises opposite to the third subcostal branch, and the last is parallel to the apical branch of the subcostal, and is produced forward for a short distance into the cell which is closed; there is no discal branch; fold very distinct, sub median vein furcate at its base. Hind wings wider than the forewings, width equal to half of their length, in form and neuration like those of *Tortrix*; the costal margin is slightly excised from the base to the apical fourth, and the dorsal margin is *very faintly* excised beneath the rounded tip. The costal vein is long, the cell is closed, short and wide, and near the subcostal vein the discal is strongly angulated towards the base. The subcostal and median are both furcate behind the cell, the superior branch of the subcostal going to the apex; the median emits a branch before the end of the cell; the fold, submedian and internal veins are all distinct. (Perhaps it would be more correct to say that the median is straight and with out branches, and that the discal is strongly angulated anteriorly near to the subcostal vein and still more angulated posteriorly near the median with a branch from the latter angle which bifurcates behind the cell). The wings are but slightly deflexed in repose, and the insect sits flat upon the surface of the object on which it rests.

H. coryliella, n. sp.

Shining black with a velvety lustre; the base and under surface of the palpi, face, anterior surface of the basal joints of the legs, and under surface of the abdomen are white; there is a transverse white spot on the discal vein of the forewings which is visible also on the under surface; sometimes it is faint and interrupted; and there is a white streak across the middle of the apical ciliæ, and sometimes the entire apical half of the cilia is white. Antennæ fuscus, hind wings shining fuscus. *Al. ex.* $\frac{3}{8}$ inch.

The larva is white and feeds on the under surface of leaves of the filbert (*Corylus Americana*), under a thin silken web which is rather large and is placed in the angle of the midrib, and a lateral vein. The web is so thin that larva is visible through it: and yet is so compact, that I at first mistook it for the loosened epidermis, and believed it to be a mine. When the larva is ready to pupate, it gathers the whole web into a dense mass around it, in the angle of the veins, and passes the pupa state under it. I have only found it in September and October, and the moth emerges in April.

Semele—gen. nov.

This genus is allied, but not very closely, to *Tinea*. In repose the species sit very flat upon the surface on which it rests, with the wings nearly horizontal but a little depressed. The tongue is rather short and is naked. Maxillary palpi well developed, pendant; labial palpi divergent, ascending as high as the vertex, with the second joint a little longer and not much thicker than the third, and clothed with scattered *depressed* bristles; head roughened as in *Tinea* nearly; Antennæ slender simple about ⅔ as long as the forewings. Wings long rather narrow (having but a single specimen I have not denuded them), the cell of the forewings is closed and they are numerous marginal veins; the cell of the hind wings *appears* to be unclosed and they have long ciliæ and are narrow, with the costal margin excised from about the middle and the posterior margin curved like a knife blade.

S. cristatella, n. sp.

Maxillary palpi yellowish white; labial palpi with the second joint dark brown with a white line along its upper surface; third joint white. Face white, vertex black, antennæ brown, and the upper surface of the thorax deep velvety black. Fourwings shining velvety black with a large spot like burnished silver at the base and not quite touching the costa, margined behind by a transverse row of raised scales; about the basal fourth is a shining silvery fascia which is slightly curved, a little irregular in outline, widest about the middle but wider on the costal than on the dorsal margin, and margined behind by a transverse row of raised scales. About the middle of the wing is another fascia of the same hue, which is a little oblique, being nearer the base on the costal than on the dorsal margin, and appearing under the lens to be slightly interrupted about the middle; it also is irregular in outline, and margined behind with a transverse tuft near the costa, and has some scattered silvery scales margining it behind from the middle to the dorsal margin, and extending back along the margin. Just before the costal fringes is a large silvery spot which extends nearly to the dorsal margin, and almost unites with the silvery scales by which that margin is marked behind the second fascia. *In* the second fascia, *on* the extreme costa are two minute white spots, and *on* the extreme costa in the large silvery spot before the cilia are two others and behind them yet two others more distinct; these last four spots are nearly equi-distant, and opposite to them, are three others at the base of the dorsal cilia. Tip of the forewings yellowish-white with some black scales in the middle of the yellowish part, and external to it is a narrow blackish hinder margined line at the base of the apical cilia. Cilia showy white. Hind wings and upper surface of the abdomen silvery tinged with golden. Under surface of the primaries brown, tinged with purple, that of the hind wings a little paler. First and second pair of legs mainly white, the third pair mostly blackish, but all annulate with white; Venter with the basal half of each segment brown, apical half yellowish white. *Al. ex.* a little over $\frac{1}{2}$ inch. Kentucky, in June. The tufts on the wings are very easily rubbed off.

The next following fourteen species are from California:

ENDROSIS—*E. ferrestrella.*

Dr. Clemens has described a species of this genus as *E. Kennicottella*, which Mr. Stainton thinks, will prove to be the well known European *E. fenestrella.* I have not seen Dr. Clemens specimens, nor have I found any species of *Endrosis* in this country. I have, however, received from Mr. Behrens, from San Francisco, specimens, which, in my judgment, are unquestionably *E. fenestrella;* and, from the relative proportions of the few species sent to me by Mr. Behrens, is by far the most abundant 'micro' in that region, as abundant, in fact, as all other species together. The specimens differ greatly, and on comparing them with Dr. Clemens description of *E. Kennicottella*, I concur entirely with Mr. Stainton that it must be *fenestrella.*

GELECHIA—*G. lacteus-ochrella*, n. sp.

Creamy white, or, perhaps, better described as white very faintly suffused with ocherous, sparsely flecked with brown upon the forewings, which become towards the tip, suffused with grayish, or purplish-brown and ocherous, so that a white costal streak at the begining of the cilia may be distinguished from the surrounding part of the wing. The cilia are yet more deeply suffused with purple-brown and ocherous-yellow. There is a minute brown spot on the disc before the middle, another about the middle, and one about the end of the cell. *Al. ex.* not quite ½ inch. California, received from Mr. Behrens.

GELECHIA—*G. maculatusella*, n. sp.

Face white; a bunch of yellow scales or bristles on each side below the eyes. Anterior margin of the thorax black, the central portion blackish but deeply suffused with red, with the tip and each side above the base of the wings. Primaries ashen white sprinkled with numerous small dark brown dots, a row of which extends along the entire costal margin which is also tinged with roseate; the wing beneath the fold to the dorsal margin is also somewhat tinged with roseate, with a few small brown spots. In some lights a large part of the wing appears strongly tinged with roseate. *Al. ex.* $\frac{3}{8}$ inch. Received from Mr. Behrens.

G. thoracestrigella, n. sp.

Palpi ocherous with the outer surface of the second joint brownish, except at the tip and about the middle, and brown annulation at the base of the third and another before the tip. Head, thorax and primaries ocherous, dusted with brown; the brown scales on the top of the thorax are aggregated into three not very distinct longitudinal streaks, the dusting is dense at the base of the costa and at the base of the wing, it is aggregated into three indistinct spots, behind which are three others, and behind these, two or three others; these spots form three oblique rows, and behind them the dusting increases in quantity to the apex. *Al. ex.* $\frac{9}{16}$ inch. Behrens, California. It is somewhat difficult to distinguish it from our *G. fuscopulvella*, ante v. 4 p. 170, but careful examination satisfies me that they are distinct. The palpi in *fuscopulvella* are much darker, a portion of the dusting on the thorax is condensed into a transverse band instead of three longitudinal streaks, and the obliquely placed spots not very distinct in this species are wanting in *fuscopulvella*. However in *fuscopulvella*, the spots on the margin of the wing are sometimes confluent, and indeed there is nothing in the ornamentation of the wings, which would induce me to consider them as distinct species, but the second joint of the palpi is larger and more brush like in *fuscopulvella*, and this, and the makings of the thorax above mentioned, sufficiently characterize them as distinct species.

G. æquepulvella—Cham.

I have also received from Mr. Behrens, specimens of this species, I have also received it from Mr. Belfrage, of Waco, Texas, and have taken it frequently in Kentucky, as elsewhere stated.

G. thoracenigræella, n. sp.

Second joint of the palpi scarcely brush-like and divided beneath. Palpi dark brown except the basal portion of the inner margin, and two annulations on the third, which are ocherous; lower face ocherous mixed with fuscus; head, thorax and base of wings dark brown. Primaries pale ocherous gray with a row of about ten brown spots on the costa, which increase gradually in size from the base towards the apex, and a distinct brown spot or streak on the disc before the middle, behind which the disc is suffused with fuscus, the suffused part being connected with one or more of the costal spots. *Al. ex.*, $\frac{9}{16}$ths inch. Behrens, California. In the dark brown thorax it resembles *G fuscomaculella*, Chamb.

G. thoracefasciella, n. sp.

Second joint of the palpi brush-like. Palpi dark brown, except the upper surface of the second joint, which is white; head, thorax and wings brown, with a blueish smokey tinge; anterior tarsi annulate with white, intermediate and posterior tarsi reddish-yellow; under surface of the abdomen yellowish, densely dusted with dark-brown; lower part of the face white, and then is a yellowish-white band across the thorax just before the tip, and the thorax and wings are microscopically flecked with white. The primaries have two oblique velvety black short streaks on the disc, each, of which, is margined before and behind with ocherous-yellow, and at the end of the discal cell is a small ocherous spot, margined narrowly behind with a line of velvety-black scales, there is, also, a minute ocherous-yellow spot just before the costal cilia, and another opposite dorsal one, and a row of small velvety-black spots around the apex at the base of the cilia, the one at the apex being margined before with ocherous-yellow. These black and ocherous spots are all small and somewhat indistinct. *Al. ex.*, $\frac{1}{2}$ inch. Behrens, California.

G. occidentella, n. sp.

Palpi with a large brush on second joint, which is brown, tipped at the apex with ocherous-yellow, and the third joint dusted with scales of the same hue. Head and face pale yellow, silver tinged; tongue dark brown; thorax rusty-ocherous, or ocherous-yellow, mixed, more or less, with dark brown, and the tip dark brown. There is a good deal of variation as to the amount and intensity, as well as disposition, of the dark brown and ocherous scales, both on the thorax and on the wings. The primaries are clothed with brown and ocherous, in about equal proportions. The costal basal portion is ocherous, passing into grayish-ocherous and brown on the dorsal margin, the extreme base of the costa is dark brown, the costal part of the middle of the wing is dark brown, while, on the dorsal margin, it is pale brown, and in this brown portion on the disc before the middle, are two small oblique velvety-brown streaks; just before the cilia is a curved ocherous fascia, concave towards the base, distinct on both margins, but indistinct in the middle from the intermixture of brown scales; the apex, behind the fascia, is brown; the cilia are grayish-ocherous, dusted with brown; a row of small dark brown spots around the apex at the base of the cilia, each margined before with ocherous-yellow. *Al. ex.*, $\frac{5}{8}$ths inch. Behrens, California.

G. grisseochrella, n. sp.

Second joint of the palpi somewhat brush-like, pale grayish-ocherous, or, rather, of a pale ocherous-yellow, tinged with gray; there is a dark brown streak perpendicular to the base of the dorsal margin, a small dark brown spot just above the fold (sometimes touching it), before the middle; following is an oblong oblique dark brown spot on the fold, very narrowly margined above with whiteish scales; there is a row of small dark brown spots along the costa, one at the end of the cell, and a row of them around the apex at the base of the cilia. The under surface of the body is sprinkled with brown, and the legs, on their anterior surfaces, are, in parts, sprinkled, and in others strongly suffused with brown. The antennæ are brown; the wings are wide, the posterior the widest, and the neuration is nearly that of *Œcophora* (*Callima, argenticinctella*, Clem. *Al. ex.*, $\frac{5}{8}$ths inch. Behrens, California.

G. ochreostrigella, n. sp.

Second joint of the palpi somewhat brush-like. Third joint slender and little more than half as long as the second. Third joint of the palpi dark brown; second joint, tongue, face vertex, a band from the head to the apex of the thorax and the forewings beneath the fold pale ocherous-yellow; the sides of the thorax are dark purple brown, and the basal portion of the forewings above the fold and extending along the costal margin as far as the middle are dark brown with a faint purple tint. All the veins and veinlets of the wing are dark brown, while the cell (which is very narrow) and the spaces between the marginal vienlets, and between the median and sub-median veins are pale ocherous-yellow. The pale ocherous-yellow of the cell and of the space between the median and submedian veins extends nearly to the base; towards the dorsal margin the course of the fold is also faintly marked with brown, the apex is brown, the ocherous-yellow spaces the veinlets, being clouded with brown in that part of the wing. When the insect is at rest it appears to be dark brown with a pale yellowish line beginning on the palpi and extending back over the tongue, head, thorax and dorsal margin of the wings to the cilia with the apical half or more of the wing except at the apex streaked alternately with dark brown and pale yellowish. The first two pairs of legs are dark brown on their anterior surfaces marked with the pale ocherous hue at the joints; the posterior pair is pale ocherous and the abdomen is pale ocherous with the basal half of each segment more or less densely dusted with dark brown. *Al. ex.* $\frac{5}{8}$ inch. Behrens, California.

G. discostrigella, n. sp.

The palpi are missing in the single specimen of this species which I have received from M. Behrens, of San Francisco. The head is creamy white with a large bronzed or purple brown spot on the vertex extending down between the eyes; the basal joint of the antennæ is purple brown tipped with creamy white, the stalk creamy white annulate with purple brown. The thorax is purplish brown margined before the apex on each side with creamy white, base of the wings purplish-brown beyond which to the middle they are creamy white, that color extending along the dorsal margin to a point beyond the middle but scarcely to the middle on the costal margin; on the dorsal margin about the middle and in the creamy white portion is an ocherous spot, and along the costal margin are two or three small brownish spots also in the creamy white part of the wing, which along the costal margin about the middle passes gradually into ocherous-yellow, as it also does on the dorsal margin beyond the middle. This ocherous hue overspreads the whole apical half of the wing. On the disc, before the middle, margining the creamy white anterior part of the wing, is an oblique black transverse spot which is narrowly separated by ocherous-yellow scales from a large somewhat diffuse brownish patch which covers the end of the cell and fades out gradually into the ocherous hue of that part of the wing. The extreme costa is marked throughout its length by small purple brown spots, which also extend around the apex at the base of the cilia which are greyish ocherous; under surface and sides of the thorax creamy white flecked with brownish scales; legs purplish-brown mixed with creamy yellow, venter creamy yellow with a dark brown spot on each side of each segment. *Al. ex.* $\frac{5}{8}$ inch. A rather handsome insect received from Mr. Behrens.

G. ocherfuscella, n. sp.

The palpi are also wanting in the single specimen of this species received from Mr. Behrens. The insect is brownish-ocherous, the head being a little paler than the thorax and wings, which, in some lights, are rusty or reddish-ocherous rather than brown; the disc just before the middle, and the costal margin about the middle are distinctly suffused with fuscus, and that is the prevailing hue of the special part of the wing; the cilia are ocherous, with a dark brown hinder marginal line at their base, and two similiar, but not distinct, lines about their middle, perhaps, instead of these two last named lines, it would be as accurate to say that the cilia are sprinkled with brown scales, showing a tendency to arrangement in two concentric lines; the antennæ are brown, very indistinctly annulate with white; the anterior and middle legs are dark brown, somewhat dusted with ocherous, and with the tarsi annulate with that hue, the posterior legs are ocherous, dusted with brown, and so is the entire under surface of the insect. *Al. ex.*, $\frac{1}{2}$ inch.

TINEA—*T. Behrensella*, n. sp.

Palpi yellowish; hairs of the face and vertex yellowish, mixed with some of a darker hue; antennæ fuscus silvery tinged; primaries brownish, suffused with pale purple, and paler towards the dorsal margin, a reddish or purplish-brown line extends along the costal margin to about the middle, when it leaves the margin, passing backwards to the end of the disc, becoming, also, wider; apical part of the wing pale purple, or purplish-slate color with white scales intermixed; cilia pale straw color; under surface and legs whitish, except the anterior surfaces of the first and second pair of legs, which are brown, annulate with yellowish-white at the joints. *Al. ex.*, $\frac{3}{4}$ths inch. Named for Mr. J. Behrens, of San Francisco, from whom I received it.

T. niveocapitella, n. sp.

Dark brown; there is a small pale ocherous or whitish spot just within the dorsal margin, placed about midway of the wing length, and margined before by black scales; head very pale yellowish-white; maxillary palpi fuscus, labial palpi dark brown, the third joint tipped with pale yellowish or white. *Al. ex.*, 7 lines. Behrens, San Francisco.

T. crocicapitella, Clem., resembles this species, but is more robust, and has the ocherous spot on the disc, and more distinct than it is in this species, and the head is not white, besides other differences.

GELECHIA—*G. saphirinella*, n. sp.

Forewings very slender, hind wings wider, and excised beneath the tip; second joint of the palpi a little thickened with scales beneath, and a little longer than the slender third joint; palpi white, with brown marks on the outer side of the second joint, and two annuli on the third joint, one near the base, the others near the tip; head white, streaked almost crimson-red, iridescenct; antennæ brown; thorax and forewings with longitudinal streaks of almost sapphire-red, intermixed with brown, gray-brown, and ocherous streaks and spots. Beneath the fold before the middle is a small brown spot, and behind it, on the fold, is a brownish streak. The streaks and spots are inextricably mixed all over the wings, but under a good Codington lens they appear more distinct, and the bright red is more conspicuous. It is a slender, handsome and graceful-looking insect. *Al. ex.*, $\frac{5}{8}$ths inch.

G. nigrella, n. sp.

Second joint of the palpi a little thicker and shorter than the acicular third joint; very dark, shining brown or black; head of an ashy-purple hue, iridescent; second joint of the palpi yellowish-white, except the basal portion of the outer surface, which is brown; the third joint becomes fuscus towards the tip; antennæ pale brown; under surface of the body and the legs yellowish, stained with fuscus. *Al. ex.*, $\frac{1}{2}$ inch.

G. trialbamaculella, n. sp.

Second joint of the palpi brush-like white; third joint shorter than the second dark brown; face white; antennæ brown; forewings dark brown but much lighter than in *G. nigrella*, which it resembles in size, and also in ornamentation when viewed by the naked eye. There is a small white spot on the fold before the middle, a costal and opposite dorsal one before the cilia, and under a good lens a few white dots are seen scattered over the wing, one of which is at the apex. Under surface of the body brown, as also are the legs, the joints of which are white. *Al. ex.* $\frac{1}{2}$ inch.

G. confusella, n. sp.

Second joint of the palpi brush-like, much longer than the third which is slender. Dark brown of nearly the same hue with *G. trialbamaculella.* Palpi sparsely dusted with white. There is a small white spot on the fold of the forewing about the middle, another opposite to it on the disc—and behind the space between these two is another minute yellowish white spot. The usual opposite costal and dorsal spots at the beginning of the cilia are present but small. It resembles *G. trialbamaculella*, but is easily distinguished therefrom not only by its larger size and the different arrangement of the spots (which in both are scarce visible without a lens), but also by the form and size of the palpi, *Al. ex.* $\frac{5}{8}$th inch.

G. latifasciella, n. sp.

Palpi simple, second joint whitish above, dark gray brown beneath, third joint dark gray brown, with its base tip and a narrow annulus before the middle white; head and anterior margin of the thorax white with a faint purplish tinge; antennæ brown annulate with white; thorax and base of the primaries dark brown, and a tuft of raised scales on each side of the thorax before the tip; just before the middle of the wing is a broad white fascia widest on the dorsal margin, and margined in front by two small raised tufts of white scales, one of which is above, and another beneath the fold; behind the fascia is a transverse row of dark brown raised scales, behind which the wing is dark brown to the cilia, where it becomes gray from the large intermixture of white scales, and there is a small irregular patch of dark brown scales at the apex; nearly opposite the begining of the cilia are two raised tufts of dark brown raised scales, and just behind them is an indistinct narrow curved gray fascia. Under the lens the apical part of the wing has a white grained color, dusted densely and as it were, overlaid by dark brown, and some white scales may be discovered as far forward as the white fascia. Under surface of the thorax white; legs white banded and spotted with dark blueish brown; abdomen yellowish white beneath with a subdued silvery luster with a dark brown spot on each side of the first segment. *Al. ex.*, $\frac{5}{8}$th inch.

I have described the most distinctly marked of these specimens, received from St. Louis, Mo., from Miss Murtfeldt, and a single specimen in Mr. Belfrazes collection from Texas. In each of the others the fascia is so densely dusted with dark brown, as to appear gray to the naked eye, the apical part of the wing is also darker gray, the tufts on the anterior margin of the fascia are largely mixed with brown, and the specimens are smaller. But I have no doubt that they belong to the same species. They were bred by Miss Murtfeldt from larvæ rolling oak leaves.

G. trifasciella, n. sp.

Second joint of the palpi brush-like; palpi, head and a wide band extending to the tip of the thorax, white, sometimes tinged with ochreous; sides of the thorax, patagia and forewings dark brown: on the forewings are three distinct oblique white fascia, one about the basal fourth, one about the middle, and one just before the cilia, the first and third being frequently obsolete or interrupted in the middle. It differs from *G. thoraceallbella* only by the presence of these fasciæ.

G. capiteochrella, n. sp.

Second joint of the palpi brush-like, third shorter than the second; head and palpi pale ocherous, the base of the second joint of the palpi and tip of the third joint dark; thorax and forewings dark brown, with the extreme tip of the thorax, and a few minute spots on the forewings, ocherous; one of these spots is on the fold towards the base, three or four others at about the middle of the wing, and there are two other minute ones in the apical part of the wing; the venter is ochreous; legs dark brown, and tarsi annulate with ochreous. *Al. ex.*, ⅜d inch.

Sometimes, the usual costal and dorsal spots before the cilia are distinct, and sometimes absent, when present, they are pale ocherous.

G. palpilineella, n. sp.

To the naked eye, this species resembles *G. nigrella*, being dark brown, almost black, and of the same size. Under the lens, however, a distinct irregular white fascia appears at the beginning of the cilia, but, which, is sometimes interrupted in the middle; the third joint of the palpi is whitish, with three narrow black lines, extending from its base to its apex, reminding one of the similar ornamentation in the species of the genus *Hayno.* It resembles *G. albistrigella*, Cham., perhaps, as closely as *G. nigrella*

G. milleriella, n. sp.

Palpi simple. Ground color very pale grayish-ocherous, almost white, marked with obscure pale yellow spots on the wings, which are, also, dusted with brown, and marked with minute brown spots; one of these spots is on the extreme costa at the base, and just behind it is another, which is in an oblique line with two others, the last, of which, is on the fold; behind this is another small one, also, on the fold, opposite, to which, on the costa, is another; there is a large brown costal spot on the costa, just before the cilia, and a small one opposite to it on the dorsal margin, and between these two, are two somewhat diffuse spots; there is a row of dark brown spots around the base of the cilia; the antennæ are yellowish, except the apical half of the basal joint, which is dark brown; the first and the base of the second joints of the palpi are dark brown, the palpi being, otherwise, of the general hue, dusted with dark brown. *Al. ex.*, $\frac{7}{16}$ths inch.

G. grissefasciella, n. sp.

Palpi simple. Insect ash-gray. There is a small oblique black streak on the forewings about the middle of the costal margin, and a pale gray or whitish fascia at the beginning of the costal cilia, a little nearer to the apex on the costal than on the dorsal margin, which reminds one, somewhat, of the fascia of *G. tephriasella*, Cham. *Al. ex.*, $\frac{7}{16}$ths inch.

G. palpialbella, n. sp.

Palpi long, slender and simple; second and third joints about equal in length, the third acuminate; palpi whiteish, except the basal joint and the base of the second joint on its outer surface; head, thorax and forewings dark grayish-brown, with obscure small spots of dark velvety-brown on the wings. Seen by the naked eye it might be mistaken for *G. physaliella*, Cham. *Al. ex.*, $\frac{7}{16}$ths inch.

G. concinnusella, n. sp.

Palpi simple, antennæ very slender, insect ash gray with three[1] or four minute brown spots on the disc. There are two narrow, very oblique, short, dark brown, costal streaks near each other, one just before and the other just behind the middle, followed immediately by a narrow white costal streak which passes obliquely back into the middle of the apical part of the wing where it meets and forms an acute angle with an opposite dorsal streak, and behind this acute angle the apex is hoary with anapical black spot or dash. At the base of the cilia there is a narrow dark brown hinder marginal line which is margined behind by a row of hoary scales. The costal and dorsal margins, at the base of the cilia, are suffused with pale ocherous. *Al. ex.* $\frac{3}{16}$ inch.

G. discoanulella, n. sp.

Palpi simple slender, third joint as long as the second, pale yellow. Basal half of the antennæ thick, apical half narrowing rapidly to the apex, the basal half with large joints, those of the apical half short and closely set. Insect, pale ocherous; head tinged with fuscus; thorax and forewings very pale ocherous, so densely dusted with grayish fuscus as almost entirely to conceal the ground color; the fold is ocherous yellow with two or three brown spots on it; there are two or three small brown spots on the disc, and a row of them around the apex. At the end of the discal cell is a pale ocherous annulus with a central dark brown spot like that of *G. discoocelella*, Cham., from which however the species is otherwise very distinct.

G. obscuroocelella, n. sp.

Second joint of the palpi somewhat brush-like, much longer than the third. Pale or whitish gray; basal joint of the palpi and base of the second joint, on the outer surface, brown, base of the extreme costa dark brown. There are three obscure brownish ocherous spots on the forewing, one of which is on the disc, another near it on the fold, and the third at the end of the cell, this last having an indistinct annulus around it. *Al. ex.* 11-16 inch.

G. subruberella—(Cham.)

In some old and somewhat worn specimens the surface markings almost, or even, entirely disappear.

G. crescentifasciella—(Cham.)

I am afraid this specific name may be misleading, as the fascia is always indistinct, and in some specimens I have not been able to detect it.

G. ocherosuffusella—(Cham.)

Possibly *G. depussostrigella* may be the same species, I correct the former description by stating that the second joint of the palpi is dusted with white instead of yellow, and the third joint is yellowish dusted with brown.

Œseis—*Gen. nov.*

Palpi long recurved the second joint with a long tuft projecting downwards, but not forward beyond the apex; the tuft has almost exactly the outline of an equilateral triangle, the base of which on the joint is perhaps a little shorter than either of the other two sides, one of which is perpendicular from the apex of the second joint. Antennæ simple about as long as the body with the basal joint a little elongate, third joint of the palpi as long as the second; vertex as wide as long face wider than its length. Maxillary palpi small (about as in *Gelechia*); tongue long, scaled.

The wings are those of *Gelechia* (some species), from which perhaps this genius should not be separated. The hind wings very faintly emarginate beneath the apex.

Œ. bianulella, n. sp.

Palpi with the tuft blackish at the base of the joint, and along the under edge of the tuft, otherwise white suffused with grayish, on its anterior edge and with a blackish spot at the apex at the tuft; third joint white a little dusted with brown, and with the apex brown; antennæ redish brown; head and thorax white tinged with ocherous and dusted with brown, and somewhat iridescent, and there is a narrow dark brown line just above the base of the wings. Forewings ocherous and dark brown streaked with white, with the base of the dorsal margin rufous, the basal portion of the costal margin white, tinged with ocherous. The colors on the wing are so intermixed as to make an intelligible description, almost impossible. The scales covering the discal cell are dark brown, with a white annulus before the middle of the wing, and a white spot or ring at the end of the cell; the wing in other portions is marked with alternate streaks of whitish, and brown many of the white streaks especially in the dorsal portion, being strongly tinged with ocherous, and the streaks are very indistinct. Perhaps it would more accurately describe the wing other than the base, and the cell as being ocherous gray, a little sprinkled with white, with the position of the veins marked by dark brown lines. Ciliæ ocherous gray. *Al. ex.*, $\frac{3}{4}$ inch.

HOLCOCERA—*H. triangularisella, n. sp.*

Palpi grayish fuscus the end of the second joint hoary or white; face whitish; head, antennæ, thorax and base of the forewings grayish fuscus; then follows on the forewings a whitish triangular fascia, wide on the dorsal margin, but narrowing almost to a point on the costal margin, and densely dusted with brown, and it is widely margined behind by a dark brown costal spot, which extends nearly to the fold and sometimes is almost triangular in form. Thence to the apex the wing is whitish, densely dusted with brown and has two minute end of the cell, under surface of body and the legs densely dusted with fuscus, the legs annulate with white, *Al. ex.*, $1\frac{1}{16}$ inch.

All of the species of this genus that I have seen are very variable and although with two specimens of this species before me, five of *H. clemensella*, six of *H. glandulella*, and one of *H. chalcofrontella* (the variation of which was noticed by Dr. Clemens), the species seem to be distinct, yet I can not avoid a suspicion that when the species are better understood in all these stages, and large numbers are available, the number of species in the genera will have to be greatly reduced. It will not surprise me if two or three of Dr. Clemens' species will include all the supposed species of that author, as well as *H. glandulella*, Riley, and those described by me.

Amadrya and Euplocamus.

Dr. Clemens suggested the resemblance of *A. effrenatella*, Clem., to *Euplocamus boleti*, and Mr. Stainton in his edition of Dr. Clemens' papers suggests that *A. effrenatella* (of which he had seen a specimen) belongs in *Euplocamus*. But Mr. Stainton in *Ins. Beit v.* 3, states that the palpi of *Euplocamus* are six jointed, and Dr. Clemens says they are small and two jointed in Amadrya, and in a single specimen of an insect which I have taken in Kentucky and believe to be *A. effrenatella*, the maxilary palpi are microscopic and so concealed that I can not determine the number of joints. *Euplocamus* also, according to Mr. Stainton, has a short tongue; but Dr. Clemens says that *Amadrya effrenatella* has no tongue; and I have not been able to detect a tongue in the specimen above referred to. In the specimen from Texas, described by me as *Amadrya clemensella*, there certainly is no trace of either tongue or maxillary palpi; but I can not perceive that it differs otherwise from *Amadrya*, as defined by Clemens, or from my supposed *Amadrya effrenatella*. In the species, described below, as *Euplocamus fuscofasciella*, of which I possess a single specimen in good condition, *I think* I can detect a trace of a tongue concealed beneath the *four jointed* maxillary palpi. (If it has six joints the two basal ones must be very small and concealed beneath the long scales of the face.) In *A. clemensella* the spots on the wings, in fresh specimens, are quite distinct but vary in form and position. Sometimes there is a long fuscus spot on the fold.

Euplocamus (?) *fuscofasciella*, n. sp.

The palpi are brown on the upper and external surfaces, and on the basal portion of the tuft beneath; on the inner surface they are yellow.

Head sordid yellowish; antennæ brown; thorax and patagia brown at base, but becoming yellowish towards the tip. To the naked eye the forewings appear yellowish, mottled with brown with some distinct brown spots, and a rather wide irregular brown fascia behind the middle, the anterior margin of which is straight from the costa to the fold, but having the posterior margin angulated backwards about the middle of the wing, at the fold the fascia is narrowed suddenly behind; the basal portion of the wing is distinctly brown, and there are two distinct brown spots in the apical part of the wing. Under the lens the entire wing appears to be traversed transversely by numerous narrow intercepted, confluent, and irregular brown lines on a yellow ground, the brown of the fascia and base of the wing almost entirely obscuring the yellow. Abdomen brownish above, yellowish beneath. Anterior and middle legs yellowish stained with fuscus with the tarsi fuscus annulate with yellowish; hind legs yellowish with some brownish markings on the anterior surface, especially on the tarsi. *Al. ex.* $1\frac{1}{8}$ inch.

TINEA—*T. apicimaculella, n. sp.*

Antennæ and outer surface of the palpi brown, inner surface of the palpi and the apex yellow; head sordid yellowish; thorax and forewings above the fold yellowish, suffused and dusted with fuscus so as to obscure the ground color; there is a large brown spot about the middle of the wing, and one at the end of the disc, and behind it the apical part of the wing, is marked with more or less obliquely transverse rows of small dark brown spots; beneath the fold the wing is but little suffused with fuscus. *Al. ex.*, ½ inch.

T. unomaculella, n. sp.

Thorax and forewings dark brown with a yellowish spot at the end of the cell; antennæ and outer surface of the labial palpi brown, inner surface and apex yellowish; head and maxillary palpi yellowish, under surface and legs yellowish marked with fuscus. *Al. ex.*, ⅜ inch.

Besides the species already mentioned found in these collections, which have been heretofore described from more Northern States, are some damaged specimens of a *Tischeria* (*T. badiiella*, Cham)? and *Tinea Maculabella*, Cham. In the latter species "the oblique irregular streak before the middle" does not quite reach the fold, and the spot towards which it points is on the fold; the "longitudinal streaks" in the apical part of the wing sometimes become more or less rounded or irregular spots. In specimens slightly denuded the costal streaks become disconnected spots.

The foregoing descriptions of "Teneina from Texas" are the conclusion of a series, the remainder of which have been heretofore published in the Canadian Entomologist. Since they were prepared I learn from Dr. Parkards' "Record of American Entomology" that Prof. Zeller has described (*Abhaud, K. K. Zoo. Bot. Ges. Wein,* 1873), many species of North American Teneina, mostly collected in Texas, by Messers Belfrage and Ball, and much the greater number of which belonging to the *Gelechidæ*. No doubt some of the species, especially of the *Gelechidæ* described by me in the "Tineina from Texas," will prove to have been previously described by Prof. Zeller, in the paper above referred to; while on the other hand, some of the species then described will prove to be identical with species previously described by me from Kentucky, and other more Northern States, in the Canadian Entomologist.

To Dr. Hagen I am indebted for another paper by Prof. Zeller (Beitrage zur Kenntners der Nordamerikanischen Nachtfaller &c., 1872), in which I find *Anesychia Multipunctella*, Cham., previously described by Prof. Zeller, as *Psecadia semilugens*, with a figure of the wings. I have no access to Hübners diagnosis of *Psecadia*. Stephens (Haust v. 4, p. 241), divides *Anesychia* into two sections, viz: "A

Anterior wings with confluent black spots, forming a longitudinal streak from the base nearly or entirely to the apex; *Anesychia* Hübner"—"B. Anterior wings with distinct black spots and blotches of variable size: *Psecadia* Hübner." *Semilugens* does not strictly belong in either section but the ornamentation is nearer to that of section A.

Review of the Glacial Theory, by S. A. Miller.

[Read before the Cincinnati Society of Natural History, May 4th, 1875].

Mr. President—It is doubtless known, to the most of you, at least, that Professor Newberry has been for several years an advocate of certain views, which he and those who profess to believe with him call the "Glacial Theory." He has discussed this theory over 200 or 300 pages of the Ohio Geological Survey, and finally laid down, in an essay of about 80 pages, in the second volume of the Geology, his "best impressions" upon the subject. It is not too much to say, that he has presented the theory, in as favorable a light, as it has been presented by any other advocate, and if it is geology, no apology is necessary for the space occupied in its consideration.

I am not convinced, however, that there is any geology in his views, or anything worthy to be called a geological theory. On the contrary, they seem to me to be a collection of wild absurdities, promiscuously thrown together. While having the highest regard for the scholarly attainments and great geological information of Professor Newberry upon matters in general, I am, nevertheless, disposed to criticise his glacial theory, and to treat it lightly. It is proper to criticise the theory of any man, even to ridicule it, because by testing it we learn its strength. Facts in matters of science will take care of themselves.

He says that the Continent, since it had its present outlines and ranges of mountains, and since the close of the Tertiary period, must have stood several hundred feet higher than it does now. Where is the evidence of such elevation, pray? He says it is proved by the great system of buried river channels. And where is that system? Echo will answer, where? He says it is proved "by the deeply excavated troughs of the Hudson, Mississippi, Columbia, the Golden Gate, &c., which could never have been cut by the streams that now occupy them, unless when flowing with greater rapidity and at a lower level than they now do." But every physicist knows, that the channels of these rivers could have been cut out, without any elevation of the continent. Without spreading over too much country, let us look at the trough of the Ohio River. It seems to have been worn out, between the time of the elevation of the Allegheny Mountains and the advent of the drift, to a depth of 100 feet or more, below the bed of the present river. The bottom of that trough is, at this place, about 300 feet above the level of the ocean, and according to probable estimates, the river will again clear out that trough and excavate it deeper, in much less time than elapsed, between the elevation of the Allegheny range and the deposit of the drift. Indeed, the fall of the Ohio River, is such, that in the course of time, it may excavate its trough more than 300 feet below its present bed. Whatever is true of the Ohio River in this regard, is alike true of the Mississippi and of all its northern tributaries. The same rule will apply to every stream that flows from the continent to the ocean. The bed of no trough, where a river now flows, or where a stream has run since the Tertiary period, within my knowledge, is lower than the ocean level, and Professor Newberry, unfortunately for his theory, has not attempted to refer to any such. In short, the excavation of the river channels of this continent do not indicate that the continent was ever higher than it is now.

But what power could lift the continent several hundred feet higher than it is now, and let it down again, without disturbing the course of the rivers and upturning the geological formations? Those who see nothing but cataclysms in the past history of the earth, and are ready to believe, if they can find it in print, that a rain storm covered the earth fifteen cubits deep, on the highest mountains, and that a man collected together the trilobites, cephalopods and whales, and fed them on salt water until the storm was over, so that not one of them perished, are prepared, no doubt, to believe that the continent was elevated several hundred feet higher than it is now, since the close of the Tertiary period, and that after it was supported up there for a long time, it was gradually lowered again to its present position, without disturbing the general geological character of the surface, merely because they find it so written in a book. Such extravagant suppositions do not constitute any part of science, nor can I see that they are worthy of being considered part of any geological theory. It has been the province of geology to show, that the economy of nature, in the formation of the earth's surface, is the same now, that it has been for millions of years—even back through the Tertiary and Cretaceous ages—yea, even back through Silurian and Eozoic time. No geologist can confidently point to a period, in the earth's history, when there were causes in activity of greater intensity or more wonderful in their character, than those now in operation. If geology, as a science, tends to demonstrate anything, it is uniformity in the laws of nature. There are no mysterious agencies, and there have never been any interruptions of the uniform laws of change. Continents are not now lifted up or depressed; they never have been. Such phenomena are physically impossible.

This continent is now elevated but a few hundred feet above the level of the ocean, and yet it has been forming through all geological time, even from the remotest. First, we had in Eozoic days an island in British America; next, in Silurian ages, several islands; then an archipelago marked the Devonian era; finally, the islands were connected together during the Carboniferous ages, at the close of which the eastern part of the continent took its present form; and later, during the Cretaceous and Tertiary periods, the southern and western outlines became fixed. Thus, from the very earliest geological periods to the present time, this continent has been forming. Deposition has been in active operation all the time, and this has been assisted from time to time by active earthquake phenomena. The most remarkable earthquake elevations in modern centuries have been in Chili, where, it is said, a narrow strip of land one hundred miles long was raised three feet high during a single earthquake, but in that inhospitable region such an earthquake is not liable to occur once in a century. Such earthquakes are mountain makers. Such earthquakes in thousands of centuries formed the Alleghenies and the other ranges of mountains on this continent. They have stamped their characters upon their work too legibly to be misunderstood. No power has lifted up continents, and no force sufficient to do it exists in nature.

A theory, having its inception in an impossibility, may be expected to be clothed with extravagant hypotheses, and so we find this one, for the next step is not a sequence of the first, but an independent statement, that there was an Arctic climate all over Ohio, Indiana and Illinois, while on the mountains of Virginia and Kentucky the climate was not materially different from what it is now. It was intensely cold over the central part of the continent, and warm and pleasant on the mountains on the border, so that the clouds of vapor could readily pass over the mountains, and "wherever there was a copious precipitation of moisture from oceanic evaporation that moisture fell as snow." From this arrangement "a great ice sheet moving from the north northwest covered all New England, and other glaciers occupied the regions east of the Mississippi and north of the Ohio."

Are we to believe that the continent was elevated sufficiently to bring about this Arctic climate—about three miles higher than it is now—and, then, that the climate was warm and pleasant on the mountains, and intensely cold in the valleys and lower lands? The continent was raised, according to this theory, several hundred feet, for no other purpose, that I am able to discover, than to get this cold. But it would require an elevation of several thousand feet to get the required intensity; so that we might as well economize our imagination at once by fixing the elevation enough, and say, approximately, three miles. Having done this, the question arises (the elevation being continental) why were there not glaciers on the Allegheny Mountains? Why this distinction in the climate of different localities in the same latitude, so contrary to all known laws of climatology? The answer, these theorists would have us believe, is to be found in the scratches on the rocks, below the gravel, in the central part of the continent, and in the absence of such markings on the bordering mountains. The statement of such facts, however, does not constitute an answer to the question, nor tend to support such theoretical views. On the contrary, such facts, standing alone and unaided by the supposition of an impossible continental elevation, are the only witnesses necessary to disprove the whole glacial theory. They do not account for an Arctic climate, nor for this wonderful diversity of heat and cold, nor is an Arctic climate or the existence of a glacier necessary to account for them.

The next step, in this theoretical collection, overwhelms the imagination. The North American continent sank five hundred feet below its present level—what for, I can't surmise, and it is quite incomprehensible to me how Professor Newberry found it out. It may be it was the result of the study of that toy called "Jack in the Box," or a scientific flight of the imagination with old Mother Goose: "Now we go up, up, up, and now we go down, down, downy.". The continent popped up, up, up to get cold, with which to make glaciers, to make scratches, and sank down, down, downy to thaw them out again. When this continent was five hundred feet lower than it is now, the ocean covered the land where the principal part of this city stands (?)

This would account for the finding of so many bones of the walrus, and the whale, and the large masses of ocean shells in the embankments around this city, if any could be found. If such specimens were found here in abundance, and there was no other way to account for their presence, than by supposing the continent to have gone under five hundred feet, by way of divine baptism, then I suppose we would be compelled to enlarge our faith, so as to take in this step, in the progress of the glacial theory. But if we know that such specimens are not found in the Ohio Valley, and that there is not a vestige of evidence, in this part of the country, indicating in the slightest degree any subsidence of the continent, we may well pause at this step, in the progress of this theory, until the Professor is able to ascertain whether that nodule, figured on page 39, was held in the glacier or in the shale while part of it was rubbed off. It seems to me that an author able to see with such certainty such vast changes and startling phenomena, so directly adverse to every known geological fact, and so contrary to that uniformity in the laws of nature, which every department of natural history teaches, ought not to hesitate, on finding a scratched bowlder, in uncertainty as to whether the bowlder was held in the ice while it was ground off on another rock, or held in a matrix while the ice rubbed the other rock over it. Such minor points as determining which stone was on the upper side, when the scratching was done, ought to be definitely settled before we pin our faith too strongly to the larger obstacles in this theory. Professor Newberry says, however, that there can be no doubt that it was ground off by glacial action. There is some consolation in this, for we may now know as a scientific fact that he can tell by looking at a scratched bowlder, whether it was scratched by an iceberg, a glacier, or a land-slide. Indeed, he says, "The track of a glacier is as unmistakable as that of a man or a bear, and is as significant and trustworthy as any other legible inscription." It has never been my fortune to see the track of a glacier, but if it is so distinct, one so conversant as he, might readily tell us whether the track on this bowlder is right side or wrong side up.

It is not necessary, to pursue the glacial theory step by step through all its continental oscillations and changes of climate, to become convinced of its inadequacy to account for the phenomena witnessed, nor is the time ordinarily occupied in an evening essay sufficient to follow it through its elaborate details and criticise it. Without, therefore, following it farther, though meaning no disrepect to the continent by leaving it in baptism, I will call your attention to some of the laws governing denudation by water and ice, to some of the evidences of the wide distribution of plants and animals, by forces now in operation, and to some of the facts tending to account for what we very correctly call the drift.

Water courses of all sorts and sizes are alike, and record the same kind of aqueous denudation everywhere. Water invariably cuts out a winding course having a transverse section like the letter V. Ice marks, of all kinds, differ from water marks. A glacier passing over a hill country will round off the hills, so that a transverse section will be represented by the arc of a circle, and hollow out and straighten the valleys, so that a transverse section will be represented by the lower part of the letter U. The valley of the Ohio, and each of its tributaries, bear the unmistakable evidences of having been worn out by the action of water alone, and not a single valley or hill bears any evidence of having been hollowed out or polished off by the action of the ice. The valleys on the north side of the Ohio River, and some of those on the south side, were filled up in part by sand and gravel during the period of the drift, but the winding course of the streams and the V-shaped valleys, where they were unaffected by the drift, and the cross sections of the valleys affected, where they have been noticed, and the rough outliers on the hills, all alike testify to the action of water and the absence of ice. I think this is the position taken by Professor Andrews in his survey of Eastern Ohio, and I think the reader will not discover that Professor Newberry has undertaken very seriously to controvert it, but rather tried to obviate bringing his glacial sheet in conflict with the hills and valleys, by moving it over westerly, beyond Prof. Andrews district, where it might have easier sailing.

It is sometimes said that the climate of the world has so materially changed during different geological periods, that there is nothing to excite our astonishment, in the assertion, that the warm climate of the Southern States, during the tertiary period, extended over the United States and Canada and as far north as Greenland, and that at the close of that period, the climate changed from the all-pervading warmth of sunny climes to an all-pervading Arctic cold; that the Arctic climate of Greenland extended south over Canada and the United States to the Gulf of Mexico, and that nearly the whole country was covered with a sheet of ice thousands of feet in thickness. But geology does not teach us, that any such material changes of climate have ever taken place, nor that any other changes have taken place, the cause of which we may not readily account for. Let us look at some of the effects of ocean currents now in operation.

Captain Mack named an island "Mimosa," in latitude 77° north, longitude 66° east, because he there picked up chestnut or mimosa beans—tropical growths carried by ocean circulation to foreign lands.

Professor Campbell, speaking of this subject, says: "To that point the equatorial current now reaches; and there the warm water must plunge under water, which, after a certain temperature, gets lighter as it gets colder, till it floats ready to freeze. Solid ice was lighter than sea water off Labrador as 9 is to 10 by bulk. In Spitzbergen the chestnuts get to 20° east, 77° north; and the warm water of the equatorial current then goes under the ice to warm the sea creatures who live at the bottom. The Fortress of Vardo and the church at Vardo are built in coral sand; it is, therefore, possible that fossil corals may have lived under similar conditions. Numbers of whales come into the fiord; thirty-two were slain by one small steamer in 1873 before August 6. Fish of many kinds abound. There is plenty of life in the Arctic basin now to make fossil corals in them. At Teredik, about seventy degrees north, I found a luxuriant vegetation on shore—the wild corn of Iceland, "Baldur's flower," the cotton grass, the "Indian tea" of Labrador, and many bright wild flowers. Geraniums and cacti live in pots in the houses; and canaries live through the winter in warm rooms. The winter's darkness does not kill; therefore, the poles need not be changed theoretically in order to account for Arctic fossils. The hills are clothed with firs and birches where there is soil enough for them to stand in. Peat is common; so materials for coal grow now, About latitude 69° north, harbors near the mouth of Kola fiord never freeze. They are sheltered from the eastern drift, and remain open all winter. A few miles fuather east, at the Seven Isles, the harbors are blocked every winter. On the 10th of June, 1873, they were still blocked; on the 15th of August snow patches lay on the beach, but no ice was anywhere near on sea or land; it had all drifted way."

The warm equatorial current now affects the climate in the Polar basın to latitude 80°, in Spitzbergen. The cold Arctic current affects the coasts of Greenland, Labrador and North America, and carries floating icebergs to latitude 37° north. That which the sea actually does for climate now, the sea may have done when the fossils of the Arctic basin lived, and when land, now dry, was submerged. Professor Dawson, of Montreal, after having studied the glaciers of Mont Blanc, and the iceberg of Bell Isle, and those which enter the Gulf of St. Lawrence, and after having studied the bowlder clay of the post-pliocene of Canada, and the striated surfaces of the rocks beneath it, and above all, the fossils of the bowlder clay, has determined, that the climate was no colder, than that which necessarily resulted from the course of the Arctic current, during the post-pliocene age, when it turned up the Gulf of St. Lawrence, carrying the icebergs with it, and striated the rocks and distributed the bowlder clay, and shells and fish of the Arctic current over the southeastern part of Canada. He says "that the casing of glacier ice imagined by many geologists, as well as the various hypotheses, which have been devised to account for it, and to avoid the mechanical, meterological and astronomical difficulties attending it, are alike gratuitous and chimerical, as not being at all required to account for observed facts, and being contradictory, when carefully considered, to known physical laws as well as geological phenomena."

In this locality, the drift consists of sand and gravel, which fills up the old river troughs one hundred feet or more in depth, in which we find, occasionally, banks of clay, loam, and sycamore trees and other vegetation that now abound in this latitude and a few degrees farther north, and less frequently the bones of the mammoth and other land animals. The lower jaw of a mammoth, with a tooth in place, now the property of this Society, was found in the gravel ridge (Ocean Terrace, Prof. Newberry calls it) at Fourth street and Central Avenue, when an excavation was being made for a sewer, at the depth of about ten feet. The distribution of the sand and gravel and other materials, including the formation of the elevated ridges and hillocks in the bottom lands, which it has pleased Professor Newberry and other theorists upon a subsiding continent to call "ocean terraces and ocean beaches"—all alike have the appearance of having been deposited by a rapid current of fresh water flowing from the north. The total absence of oceanic remains, in these ridges of sand, gravel and clay, and the presence of land animals and plants of this and more northern latitudes, seem to me to be conclusive on the subject. That jaw and tooth of the mammoth, from Fourth street and Central avenue, are alone sufficient to put to shame the whole theory of ocean terraces and beaches, elucidated in the Ohio geology. We might easily imagine a smile, on that old jaw in the case, at the idea that it was ever used to crack shell fish, or that it was caught on a gravel bank, by the slow approach of waters in the arm of an ocean.

The sand and gravel beds and ridges, from here to the Gulf of Mexico, bear the same evidences of deposition from rapidly flowing streams of fresh water. The fossils from this locality abound in Southern drift, as the fossils from more Northern climes abound in it here. The Northern lakes are lined with beaches, especially on the Northern side, that are higher above the level of the ocean than the highest hills in this vicinity. If we couple the facts determined by Professor Dawson, with the phenomena as presented by the beaches surrounding the lakes and the distribution of the sand and gravel from the lakes to the Gulf, we may readily conceive how this Arctic current, entering the Gulf of St. Lawrence freighted with icebergs from Greenland, would so increase the cold in post-pliocene times that the St. Lawrence River and the river that led from the lakes to the Hudson River Valley would be frozen up, and kept closed during the summer season, while the lakes, losing but little by evaporation, would continue slowly to rise until one great lake would occupy the central part of the continent, and reach to that latitude, where glaciers would enter it from the north, and "calve" into icebergs, that would be carried south across the lake by winds and storms, or by the current, when it overflowed the hills of Northern Ohio, Indiana and Illinois. These icebergs would make the scratches, that are found beneath the gravel, and transport the huge Laurentian rocks and bowlders of Canada, that are found south of the lakes, for a distance of two hundred miles or more, while such a torrent of water, as would result from an overflow of the lake and the breaking of its barriers, would transport the icebergs, and carry with it the sand and gravel and earth of the higher lands, and distribute them all the way to the Gulf. The different beaches surrounding the lake would represent the height of the water, before each great overflow and destruction of the barriers, and finally, when the Arctic current ceased to affect the climate, the water from the lakes would again flow in the natural channel to the ocean.

Such a theory will account for all the phenomena presented by the drift in this locality, and all that I have observed elsewhere, though I have traveled some over Canada and Mississippi and the intervening States. It involves no elevations or depressions of the continent, no changes of climate, beyond what would be inevitable from the change of land and water surface, and the changed course of the Arctic current, and it requires the intervention of no extraordinary or mysterious power. It may not, however, account for everything witnessed by Professor Newberry and others in the neighborhood of the lakes; but if it fails to give full satisfaction, we may look elsewhere, within the range of probabilities, for the true cause or causes of such anomalous facts, without being driven to seek a solution in the labyrinth of impossibilities with which the whole glacial theory is charged.

Natural History Investigations in Florida Waters and Among the Keys.

By W. W. Calkins.

> "Awake my St. John! Leave all meaner things,
> To low ambition and the pride of kings."

These lines occurred to me as our little schooner under full canvas, sailed gaily along over the Gulf of Mexico, at the rate of six knots an hour. The day was such as can only be found on these Southern summer seas. The dashing spray and the dancing wave brought to us many a choice specimen of the Fauna and Flora of the Gulf.

Armed with dip nets, my fat friend, the Doctor, and myself, stood leaning over the rail, fishing up the floating weed, from this we procured crustaceans, shrimps and litiopa. The Tortugas Cruise and our narrow escape from shipwreck there, were now forgotten in the enjoyment of the present happiness. Arriving in Key West, the next few days were devoted to preserving and shipping our large collection of specimens. These required over thirty barrels and boxes. As my friend Pablo, the cook, remarked, they were fully an "equivalent" for our labors and dangers on the most perilous coast known. While we remained in Key West, I made some additional collections and secured several species not enumerated in my former letter. I also came near losing my coat, in so comical a manner as to be worth relating. Returning one evening from a stroll up the beach, and being late I retired to my room at the hotel, where having disposed of the spoils stowed away in my numerous pockets, I lay down for a rest. The coat mentioned, I had hung up, as usual, on the floor. Sometime after, I was aroused by a tremendous clatter, clawing, etc., quite mysterious. Looking up I saw my coat going out the door, at first I thought the house was haunted and the spirits were on a frolic, or else, the devil himself was after me. But remembering what my mother said about ghosts, and having seen several in a more material form, I resolved to investigate. About this time, I thought *Gelasimus minax!* My pockets were filled with "soldier crabs," and not having removed them, when all was quiet, they determined to vindicate their rights, as royal Americans to liberty. It is needless to say that I was more careful after this. But the objects we desired to save were so numerous and interesting that room for all was hard to find. My 'party' were known as 'Bug-hunters;' though we did not deserve the title, I suspect however, that the natives confounded us with an old fellow who was stopping here and making a specialty of moths. On some of our trips in this and other cities, we were generally accompanied by from ten to twenty black and tans of small size. So long as our "nickels" held out we found it easy to command the services of a regiment if necessary, and with a little showing, the young Nubians soon made good collectors, diving into out of the way places with the same facility that a "terrier" goes for a rat hole. While watching them I thought and wondered if old Diogenes himself would not admire our way of teaching science. Diogenes who was a teacher of economy was a pretender. He required the luxury of a tub to live in, he should have gone West where it would not be necessary. But I must resume the dry details of science I suppose, to preserve the reputation it has for being thus. My rambles on the Island of Key West were rewarded by the following additional species.

Succinea campestris, (Say). This shell occurs abundantly in low places clinging to coarse grass. At first, I mistook it for *Bulimus* on account of its form and the numerous brownish stripes, a peculiarity that I have not noticed elsewhere. *Cerithidea scalariformis*, (Say). Abundant on salt marshes subject to inundation. From small mangrove sprouts, I have taken hundreds in a short time.

Truncatella subcylindracea, (Gray). I only found occasionally, in company with *T. bilabiata*, (Pfr.,) under leaves and logs. Of the latter species there are millions. *Helix cereolus*, (Muhf.,) grow to a large size and may be classed with *H. septemvolva*, (Say). My friend, Mr. Binney, to whom I have forwarded a number of live species, says he finds no difference in the animals, of the two mentioned above. *H. carpentereana*, (Bl.,) so called, need study. They are abundant on Key West. The *Orthalicus*, known as *undatus* and *zebra*, were formerly more plentiful here, than at present, I find a marked difference between these and the specimens collected by me further north, notably, on Sandy Key and Cape Sable. *One* seems to resemble a Central American species. In regard to a number of mollusks found by me among the Keys, those who are interested in the study will be glad to know that I was successful in transferring safely home nearly one hundred species, in alcohol, as well as some alive. The land mollusks, or rather, a portion of them are now in the hands of W. G. Binney. And from recent letters, I am assured that the results, soon to be published, are most interesting. *Cylindrella Pocyana*, (D. Orb.,) This elegant species resembles *C. jejuna*, (Gould), very numerous in gardens around Key West. In the same localities I found now and then a few *Glandinas*, which I am assured on good authority, are new species. However, I am not disposed to take the *ipsi dixit* of any man until the matter has been fully investigated by the best scientists in the country. The foregoing species and those noted in the April Quarterly were sufficient to render my stay at Key West very agreeable. But in addition, I obtained some fine marine specimens from the Harbor, such as *Echinaster spinosus*, *Holothuria nobilis*, *Marginella carnea*, etc. The pipe coral, or *Manicina areolata*, (Ehr.,) and *Astrea cavernosa*, are also abundant from Tortugas to Cape Sable, to say nothing of the other species common to Florida waters. The whole coast presents a series of keys raised by the coral insect from the depths of the ocean, and enlarged by drift and accretions to their present dimensions. The mangrove has largely completed the work begun by its peculiar growth. The fruitlets of the tree may be found floating all over the gulf, and at first, I mistook them for cigars, which they resemble in size and shape, one end being heavier than the other, it readily takes root wherever there is the least soil, they grow in the water as well as out and form a regular net work of roots on the edge of the key, thus providing a protection for them and at the same time retaining the debris that may be washed ashore. This process may be seen best at Markesas, where a shallow lagoon is fast filling up in the manner mentioned. But to study all the wonders of this southern clime would require months and I had only weeks. So having completed our work at Key West, and our vessel being completely fitted out for another cruise, we, on the morning of Feb. 17, sailed out of the harbor with a lively breeze and headed for the North to study the Fauna of some other localities. A six hours' run of thirty-five miles and we anchored at Bahiahonda Key, a low barren island overgrown with mangroves and cabbage-palms. (*Chamærops palmetto*), we found that a portion of the key had been recently separated from the other part by some tremendous storm. A strong current now ran between the two. In our little "dingy" we crossed this and found on the barren rocky island some interesting species. *Nerita peloronta*, (Lam.,) grow here to a very large size. The other species found here were, *N. tessellata*, (Lam.,) *Lit. muricata*, (Lam.,) *Lit. angulifera*, (Lam.,) *Lit. nodulosa*, (Desheyes), *Phorus corrugatus*, (Reeve), (rare), *Avicula atlantica*, (Lam.,) *Modiola sulcata*, (Lam.,) a species that is limited as to range in this region, *Modiola tulipa*, (Lam.,) *Strombus bituberculatus*, (Lam.,) *Arca noae*, (L.) *Marginella apicina*, (Mke.,) *Marg. roscida*, (Redf.,) *Cardium isocardia*, (L.) In a lagoon I obtained specimens of *Bulla occidentalis*, (Ad.,) *Cerith. eburneum*, (Brug.,) *Cerith. litteratum*, (Born.) All the above were live species. In the shallow waters adjacent, were *Holothuria*, *Echinus*, and starfish in abundance. Our work here occupied the rest of the day, so we lay at anchor to-night off the key at the entrance, to what is called Vaccas Bay. Some ten or twelve coral built islands form a sort of harbor ten miles long and four or five wide. Numerous channels divide these keys. The waters are quite shallow and we were frequently able to walk around and collect on the bars, keeping a good lookout for the tide and sharks. The tiger-shark is said to have a particular fondness for legs, as yet, we had not taken any on this trip, but our harpoons were in readiness and the boys were anxious to get a regular old "man eater." While we lay at anchor this evening, I counted over thirty small schooners within ten miles of us. These were engaged in sponge fishing. And Vaccas Bay is a favorite sponging ground. The next morning we sailed up to Vaccas Key, and intending to spend a day here anchored off the island. The results of our work embraced some interesting species. *Chiton piceus*, (Gmel.,) were clinging to the rocks by hundreds. We found some thirty fine specimens of *Turbinella muricatum*, (Lam.,) near the key in shallow water. *Uros. cinereus*, (Say), and *Turbinella cingulifera*, (Lam.,) were abundant. *Marg. guttata*, (Dill.,) this fine shell seems to be rare. Of *Asterioidea*, we obtained specimens of *Oreaster gigas*, (Lut.) very large, and *A. floridanus*, (V.) *Arbacia punctulata*, (Gray), we obtained some. The fish were represented by a number of interesting species, such as the toad and cow-fish. I examined the land closely but found no species of mollusks differing from those previously stated. On one of the keys we added to our Commissary department a number of cocoa nuts, the milk in them was very welcome. The pa-paw (*Carica papaya*), grows here as elsewhere. No human soul inhabits these lonely islands. The "spongers," however, use them for drying their sponges after they have kept them in pens built in the water near by, for a week or so, and until the gelatinous matter is expelled by the action of the waves. We had here a fine opportunity to study sponges on their native ground, but not being able to embrace the whole realm of nature in our investigations and thinking something smaller would do just as well, we did nothing beyond getting a few specimens of the different kinds, such as glove, finger, sheeps wool, and loggerhead. Having looked over as much ground as possible, we loaded up our collections and on a stormy morning set out for Sandy Key, across Florida Bay some twenty miles. The sun shone brightly but the wind blew a gale. However, it was in the right direction to shove us along at the rate of seven knots an hour, with only our mainsail set. So we enjoyed the fun, sea sickness never troubled me, but my companions *du voyage* were not so fortunate. The Doctor found some relief though, by lying down on the deck and chewing cabbage palm, until the monitor within warned him to desist. In less than three hours we were at Sandy Key, and it is well named, being only a mile long and not more than ten rods wide in the broadest part. There being no harbor we were obliged to anchor at some distance on account of shoal water. The little vessel bumped around lively, but there was no help for it, and so we all went ashore in the "dingy" to ascertain what we could find. Getting ashore was a work of some difficulty, but none of us were afraid of a little salt water, as we went plunging in over the breakers. The Doctor and myself began at once to examine the island. The trees we noticed to be larger than any we had seen, and among them I saw the mastic gum, a sight that did me good, for I knew they were the favorite resort of certain land shells. In a short time I found *Orthalicus zebra*, hibernating about ten feet from the ground. The gum-tree has a smooth and slippery bark but

I made my way up with much greater facility than the fellow who climbed the greased pole for a pig. My shout of victory brought the Doctor through the bushes and cactus in such a hurry that his rear-guard was picked off, by the thorny enemy. However, we had both fought, bled and died for our country, and the Colonel did not mind this little brush. I noticed at once the difference between this and other species previously found. And I now have the pleasure of knowing that the highest authority in this country has established some interesting facts in regard to this shell, from specimens collected by me on Sandy Key and Cape Sable. Well, this first prize stimulated the Colonel and myself to fresh exertions, notwithstanding the limited area of Sandy Key it is pretty well covered with mangroves and other trees. And among these a dense undergrowth of brush and *Cactaceae*. In our search for *Orthalicus* we had to force our way through at the expense of bleeding limbs and torn clothing, however, it paid as we obtained dead and alive, some two hundred specimens. The blood—I mean perspiration—ran from every pore and we had to sit down among the cactus to cool off. The Doctor regretted having left his soothing syrup behind, but a little forty rod revived our spirits wonderfully, and though we had as yet, seen no snakes in Florida, we might in a short time, have seen a whole menagerie if the supply had held out. But the canteen leaked and we blamed the cook. We are strictly temperate. After this we proceeded more cautiously, but found no new or interesting species, unless it be soldier crabs of unusually large size. From the number of dead *Orthalicus* at the foot of gum trees, I have no doubt that the soldier crab is a Frenchman. As night was coming on we retraced our way to the vessel, only stopping once on the beach to examine a curious phenomenon. This was no less than a regiment of horsefoot crabs (*L. polyphemus*), coming up on shore from deep water to deposit their eggs. The male accompanies the female and may be known by its smaller size. Having dug into the sand where the tide reaches, the eggs are milted by the male and left to shift for themselves. They were making a great fuss and evidently having a fine time. I should compute one such deposit to number many thousand eggs. Before leaving the Key, we examined them further, we got home just in time to avoid being left ashore all night, as a tremendous Norther came up and made everything howl. We crawled down into the humble quarters termed a cabin and after a slight repast of green turtle, conchs, and crab chowder (smile not, they are good), we turned in. Meantime the gale continued and increased in violence. But this did not prevent our sleeping sweetly while we rocked on the tossing billows and were lullabyed by the hoarse roar of the waves and the creaking of the ships cordage. About midnight, however, I awoke to find myself rolling out of bed. Going on deck I saw that we were dragging our anchor. I called the Captain who concluded to run out the other anchor. We then turned in again and slept until day break. Everything was again quiet and looking around we saw hundreds of acres entirely bare of water. A glorious sight, for we were thus enable to collect many rare shells that could not be secured under any other circumstances. Six miles from Sandy Key and in sight was the mainland, Cape Sable. We ate a hurried breakfast and gathering up our baskets disembarked and began work among the *Pinnas*, *Fasciolarias*, and other wonderful things on the mud banks. It proved a profitable day, as the loads of shells, each of us found, testify. The list is too long for this paper, and so I must regretfully drop the subject.

Description of a New Species of Trilobite. By C. D. Walcott, of Trenton Falls, N. Y.

Genus *Spherocoryphe*—(Angelin.)

Spherocoryphe robustus, n. sp.

General form subovate, convex; cephalic shield subtriangular, strongly convex; anterior and lateral margins smooth, round edges; posterior lateral angles produced into long subuliform spines; posterior margin nearly transverse; glabella subglobose, constricted at the base, projects beyond the anterior and lateral margins; two minute rudimentary lobes are separated from the anterior lobe by deep furrows each side of the central axis; neck furrows broad and shallow upon the central axis, deepens laterally, and extends tothe posterior lateral angles; neck segment a narrow elevated ridge; movable cheeks triangular, convex.

Eyes prominent, subglobose, directed forward and outward from the central eminences of the cheeks; visual surface occupies the outer lateral margins; facial sutures, as far as determined, extend from the posterior third of the lateral margins to the posterior base of the eyes, thence to the top of the eye, curve around the outer margin and then down to the anterior base.

Thorax a little longer than the cephalic shield; axial lobe with ten segments, arching forward, narrows very gradually, posteriorly as wide as the lateral lobes; lateral lobes flattened two thirds the way out, where they abruptly curve downward, narrow slightly posteriorly; pleuræ straight and transverse, two thirds of their length, where they are geniculated, curving slightly backward, terminate in short mucronate spines.

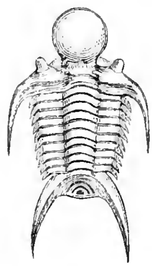

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Fig. 18, *a.* *Spherocoryphe robustus.*
Fig. 18. *b.* *Spherocoryphe robustus; section of glabella.*

Pygidium, mesial lobe composed of three segments, anterior segment largely developed, its extemities being produced into long stout spines, incurved toward their points; posterior margin a rounded ridge, curving backwards between the spines, forming a subtriangular depression, upon which, the two posterior segments are situated; entire surface finely granulated; upon the upper surface of the globose glabella the granulations are coarser, so as to be distinguished by the eye.

This species is related to *S. granulata* (Angelin), and *S. salteri* (Billings), but differs materially from the descriptions of those species.

Formation and locality: In the upper third of the Trenton Limestone, Trenton Falls, New York.

Some remarks on Plumulites Jamesi of Hall and Whitfield.
By S. A. Miller.

Through the kindness of U. P. James Esq., I have been permitted to copy the description (which will appear in the forthcoming volume of the Ohio Paleontology) of *Plumulites jamesi*, by Profs. Hall and Whitfield. It is as follows:

"General form of plates triangular, with the apex a little inclined to one side, the lateral margins gradually and rapidly diverging from the initial point, one of them considerably longer than the other. Basal margin sigmoidal, the convex portion situated next to the longest lateral face, the concave portion to the shorter, and the shorter lateral margin deflected downwards in some cases (probably the marginal row of plates)."

"The surface of the plates is flattened or slightly convex on the sides, and very faintly depressed along the middle, the whole marked by rather closely arranged, annulating and scaliform transverse lines parallel with the basal or sigmoidal margin, and marking stages of growth. These transverse lines are usually faintest near the apex, and gradually increase in width with the increased growth of the plate, but in some cases they are quite irregular in their distances."

"The length from the apex to the basal margin of the plate is usually a little greater than the transverse diameter, and seldom exceeds a sixteenth of an inch, the largest specimens seen not measuring a line in their greatest diameter."

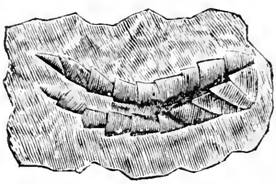

Fig. 19. *Plumulites* (?) *jamesi*; magnified 2 diameters.

It will be observed, that Hall and Whitfield were in possession only of detached plates, which they determined to belong to the sub-class *Cirripedes*, and referred to the genus *Plumulites*. Such detached plates are common, and found at all elevations throughout the Cincinnati Group. While the general form is triangular, they are more or less inequilateral, and differ from each other very much in form and size. And, I can scarcely think, that the transverse lines on the plates, mark the stages of growth, as suggested by the foregoing description.

J. Kelly O'Neall, of Lebanon, found a specimen, which he has kindly furnished to me for illustration and description as shown by Fig. 19. It consists of two series of these plates, apparently connected at one end by an overlapping plate, but, which, gradually separate toward the other end. Each series is arranged in the form of a curve, but, it is possible that the curve is the result of accident or pressure. There are ten plates in each series, more than half of each of which is covered by the overlapping plate, except the first plate in each series. The arrangement of the plates is as follows: The outer series (or lower series, as it appears in the figure), has the concave side of the series formed by the rapidly deflected lateral margin of the plates, with the apex of each valve on the concave side. The inner series (or upper series, as it appears in the figure), has the convex side of the series formed by the rapidly deflected lateral margin of the plates, with the apex of each valve on the convex side. These facts indicate that the two series of plates are in their normal position, unless, it be a fact, that the curve is the result of accident, and that the first plate in the lower series is a little moved out of place.

In the cabinet of C. B. Dyer, Esq., there is a specimen showing an interior view of a series of six plates. The exposed surface of three plates has a length of $\frac{14}{100}$ inch, where the plates are $\frac{9}{100}$ inch wide. The specimen has the appearance, to the unaided eye, of a small angular gutter of smooth overlapping plates, having one side three times as wide as the other, but an ordinary glass will detect the tracing of the transverse lines, that mark the other side of the plates. The narrow reflected margin, on one side, forming, with the broader expanse of the plates, a gutter, is exactly such a view, as we would expect to find, by looking at the interior of the second, third and fourth plates of each series in figure 19; other plates, however, in this figure, would lead one to expect to see a more gradual curvature, in the form of the gutter.

The two series of plates must, therefore, be regarded as distinct, though they might have been connected at the bottom of the depression formed by bringing together the abrupt sides of each. They never could have been arranged, in the overlapping style of the plates in *Loricula pulchella*, and other Cirripedes. Nor does there appear to be any reason for supposing, that any other plates were joined or interlocked with either of these two series, forming with these a pine cone arrangement.

The sessile *Cirripedes*, according to Mr. Charles Darwin, are first found, in the Eocene Tertiary, and subsequently abound, in the more recent deposits, and in the present seas. Our specimen is not a sessile *Cirripede*, because it did not attach itself to another object. The oldest pedunculated *Cirripede*, known to Mr. Darwin, was from the lower Oolite, but since his great work, the naturalists have found them, at a much earlier period and now commonly refer numerous Silurian Crustacea to this class. Mr. Darwin, says: (monograph of the fossil *Lepadidæ* or pedunculated Cirripedes of Great Britain).

"That in the several orders of Cirripedia such important differences of structure are presented, that there is scarcely more than one great character, by which, all Cirripedia may be distinguished from other Crustacea; this character is, that they are attached to some foreign object, by a tissue or secretion (for at present I hardly know which to call it), which debouches, in the first instance, through the prehensile antennæ of the larva, the antennæ being thus embedded and preserved, in the center of the basis. The cementing substance is brought to its point of debouchement, by a duct, leading from a gland, which (and this is perhaps the most remarkable point in the natural history of the class) is part of and continuous with the branching ovaria. When we look at a Cirripede, we, in fact, see only a Crustacean, with the first three segments of its head much developed and enclosing the rest of the body, and with the anterior end of this metamorphosed head fixed by a most peculiar substance, homologically connected with the generative system to a rock or other surface of attachment."

It will appear that the character, upon which the Cirripedia are distinguished, from other Crustacea, is not only wanting, in our specimen, but it will require some ingenuity to construct the animal and supply this character. The two series of valves or plates do not overlap, as they do in *Scalpellum ornatum*, or in *Loricula pulchella* and other species described by Mr. Darwin. Indeed, about the only resemblance, between our specimen and any well determined Cirripede, is to be found in the surface ornamentation, which is of very slight importance, in determining its affinity. It is not therefore too much to say, that we are by no means certain, that we have here, under consideration, a fossil Cirripede, and that it may be possible, that we have the long sought for appendage to Billing's trilobite. Against the latter view, in addition to the fact, that nearly all naturalists think it quite improbable that a trilobite had any such appendage, it may be urged, that the plates are not tuberculated as all trilobites are, but transversely lined, in a way, essentially different, from the markings on any known part of a trilobite; moreover, it is difficult to see how such legs could be disposed of when the animal curled up, and why it is that the plates are not specially abundant, among the remains of trilobites, instead of being somewhat uniformly scattered through the rocks, without regard to the quantity of fragments or well preserved trilobites, where they most abound.

Glyptocrinus Shafferi. (S. A. Miller).

Body very small, only a little larger than the column, and without sculpture or other ornamentation. Basal pieces small, pentagonal; radial pieces small and wider than long. The third radials support, on the upper sloping sides, the free rays of the crinoid. The radials form a longitudinally convex elevation above the interradials, which give the short body a somewhat pentagonal appearance.

Only three interradial plates appear in the figure, and, though I have examined several, otherwise, very good specimens, I have been unable to discover the outlines of more than three plates; but from these examinations, I am led to believe, that there are six interradial plates or minute pieces arranged about as in other species ofthis genus.

Arms rise free from the third radial, cylindrical on the outside,

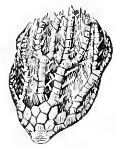

Fig. 20. *Glyptocrinus Shafferi*, magnified 2½ diameters.

bifurcate, in one specimen on the twelfth plate and in another specimen on the ninth plate; (the figure was made from the latter specimen, but by mistake only seven plates appear in each of two rays); and run to a point, from twenty to thirty pieces distant without another division. Each plate or arm piece supports, on a shoulder, on one of its inner lateral sides a comparatively large and strong pinnule. The pinnules are alternately arranged on the inner lateral sides of the arms and are composed of pieces three or four times as long as wide.

Column large, compared with the size of the pelvis; composed, near the head, of alternately thicker and thinner pieces, but a short distance below the head, three, four or more thin plates intervene between the thicker ones, presenting the appearance of a string of little spools.

This species is distinguished from others, by its small, smooth body, coarse pinnules, and free arms, above the third radial. The cup terminates with the third radial. The column is distinguished from any other in our rocks, by the distance between the larger plates, which gives it the appearance of a string of little spools.

The range seems to be about the same as that of *G. decadactylus*, or between 300 and 450 feet above low water mark, at Cincinnati. It is quite rare among the collectors, only a few specimens having been thus far found.

The specific name is given in honor of D. H. Shaffer Esq., who found the specimen figured above, and kindly gave it to me, for examination and description. It is a very handsome free specimen, with all the arms and pinnules folded together, but the figure was engraved from a photographic view, which elevated the lower part of the body, at the expense of the upper end of the arms and pinnules. Dr. C. A. Miller has a splendid specimen on a small slab which clearly shows the bifurcation of the arms on the twelfth plate from the cup or third radial, while this specimen shows the bifurcation on the ninth plate. The specimens are about the same size and otherwise present the same appearance.

Heterocrinus isodactylus—(S. A. Miller).

Fig. 21. *Heterocrinus isodactylus.* Natural size.

Body small and tapering but very little to the column. Basal pieces pentagonal, about $1\frac{1}{2}$ times as wide as long; first radial pieces longer than wide and quite convex longitudinally; second radials nearly as long as wide and longitudinally convex.

The arms bear a striking resemblance to those of *H. heterodactylus*, but as I have only one specimen showing the arms, and it being somewhat imperfect, I am unable to designate the particular differences if any exist. It will be observed, that the basal pieces are proportionally wider, and the first radials proportionally longer, in this species, than they are in *H. heterodactylus*.

Column very large in proportion to the size of the body, round or sometimes slightly pentagonal, and composed, near the head, of alternately thicker and thinner pieces. It is from the character of the column, that this species may be readily separated, from the *H. heterodactylus*, which it most resembles. The column is usually quite round though sometimes it is slightly pentagonal, the plates, however, are continuous discs and show externally no separation into pieces, such as always characterize the *H. heterodactylus*.

The specimen figured is an unusually large one. Some specimens have not half the diameter of this one. Its range is from low water mark at Cincinnati to the top of the hills but specimens are quite rare.

This species has been called *isodactylus* for the past two or three years, though it was never before figured or described. I have retained the local name though the species is not egnol fingered.

Crania reticularis—(S. A. Miller).

Shell small, subelliptical in outline with a straight cardinal margin, or sometimes more nearly circular in outline. Dorsal valve moderately prominent; apex prominent, acute and situated close to the cardinal margin, in fact, it seems by its abrupt termination, to form part of this margin.

Fig. 22. *Crania reticularis.* Magnified 3 diameters.

Surface marked by punctures, arranged, as shown by the figure, in a peculiarly beautiful manner. The rows of punctures, from the cardinal margin, on each side the apex, curve downwards a little, as they ascend toward the apex. The rows as they leave the lateral margins form the same curves, so that the rows soon cross each other, giving the punctures the rhomboidal form, and the surface the checkered appearance, formed by curved lines gradually approaching and crossing each other, like "engine turnings" on a watch-case.

Length of a specimen 0.08 inch; width 0.11 inch; convexity 0.04 inch.

The specimen figured is one of a number found, attached by the lower or ventral valve to the under side of a worn piece of *Tetradium fibratum*, near Brookville, Indiana, by Mr. Ed. R. Quick, a collector of that place. The specimens vary in form considerably, but the punctate surface is as distinct and uniform as it is in *Trematis millepunctata*. The shell has the same appearance, that the shells have in the latter genus, and it may be, that it is a true *Trematis*.

The acute apex and the variability of form, however, have induced me, at present, to class it with the *Crania*. The lower valve and interior are unknown.

Some further remarks upon the genus Anomalodonta.

By S. A. Miller.

Prof. C. A. White takes occasion, once in a while, to criticise the the genus *Anomalodonta*. This he has a perfect right to do, in his own way, and if he showed an ordinary respect for truth and fairness, I would enjoy his criticisms, and be only too glad to republish them. Indeed, no man has any right to object to a truthful criticism of his work, but ought rather to invite it. His reply, however, in the April No. of the American Journal of Science and Arts, to the article, which appeared in this Journal in October last, is so manifestly unjust, not to say intentionally false, that its reproduction can have no value, beyond the opportunity afforded for exposing his misrepresentations. He says:

"Mr. S. A. Miller, in a reply to my note on the above mentioned genus, published in the October number (1874) of the Cincinnati Journal of Science, endeavors to defend his substitution of the name *Anomalodonta* for Meek's earlier name. This he does on the ground (1) that *Megaptera*, having been previously used for a genus of whales, could not stand; (2) that although Mr. Meek had subsequently (but previous to the publication of Mr. Miller's name) proposed to substitute for it the name *Opisthoptera*, he did it only *provisionally*, and had not himself adopted it in the subsequently published Ohio Report; and (3) that neither Meek and Worthen jointly, nor Mr. Meek alone, had fully defined the generic characters of their type.

To one familiar with the article, in the October number of this Journal, upon the genus *Anomalodonta*, the misrepresentations in the foregoing paragraph are apparent, but as some, who will see this, have not and will not see the former, it can only be proper to say, that neither Meek and Worthen, nor Meek himself ever defined the genus *Megaptera* or *Opisthoptera*. Meek and Worthen had a shell having all the characters of an *Ambonychia*, so far as they could see, and they saw the cardinal teeth as well as the exterior, but it had a wing unusually prolonged. They named it *Ambonychia Casei*, and suggested, that if it should prove not to be a true *Ambonychia*, it be placed in a sub-genus, for which they proposed the name *Megaptera*. Later Prof. Meek said, that if this shell should prove to be the type of a sub-genus, the name *Opisthoptera* might if desired be substituted instead of *Megaptera*. No character of generic or sub-generic value was defined or suggested and consequently the names suggested were not applied to anything. And furthermore it was quite fully shown, in the October Number of this Journal, that *Ambonychia Casei* does not belong to the genus *Anomalodonta*, but on the contrary belongs to the genus *Ambonychia*, where Meek and Worthen placed it, and has no characters sufficient even to found a sub-genus—In other words it is an *Ambonychia*, simply that and nothing more. I have not, therefore, attempted to substitute the name *Anomalodonta*, for Meeks earlier name, but on the contrary, if *Megaptera* or *Opisthoptera* could live, as generic or sub-generic terms, they would not be in conflict with *Anomalodonta*, and when Prof. C. A. White, in a distant Journal publishes the statement, that I attempted to substitute a name for a genus, already provided with one, on the ground, that the earlier name had not been "fully defined" he does it, without any regard for the truth, because in the discussion of the subject, I said nothing about "fully" defining a genus or a sub-genus, but did show, that there had never been any attempt at a definition of these words by Meek and Worthen, or Meek alone. He continues his article, however, as follows:

"No further notice would be taken of the matter, were it not that silence might be construed into acquiescence in views and practices that it is the interest of all working naturalists to discountenance. In the first place, it is by no means a *settled* question among naturalists that the same name may not be used for genera in different sub-kingdoms, or even in different classes of the same sub-kingdom. This is the practice of some of the best and most renowned naturalists. *Troglodytes* is constantly used for a genus of apes, and also for a genus of birds, and many other cases might be mentioned. [What others?] I think, however, with Mr. Meek, that it would be better to change the latter name, but he seems to have deferred to the high authority mentioned [what?] in only provisionally proposing to change it in the case of *Opisthoptera*. That he did not formally adopt the latter name in the Ohio Report has no bearing on the question. [Indeed!] By repeating there the previously published note on *Opisthoptera*, he manifestly repeats the proposal to substitute the latter name on precisely the same ground that he did at first, namely, in case it should be found generically distinct from *Ambonychia* and the name *Megaptera* should be objected to. But it would not have altered the case if he had there said nothing about it, or even if he had proposed to retract both *Megaptera* and *Opisthoptera* entirely. As soon as the name was published it became the property of science, and he had no more right to dispose of it than any other person."

"Mr. Miller's argument that both *Megaptera* and *Opisthoptera* should be discarded because *full* generic descriptions of them were not published, is not, and can not be, sustained by general usage. Even in recent zoology, where it is possible to ascertain clearly all the characters, no such rule is generally followed. Such a rule would be utterly inadmissable in the department of fossil shells, because of the exceeding rarity of specimens that are even approximately perfect; for even in the best specimens the most important features (as, for example, the internal markings and teeth in bivalves) are generally obscured. Consequently, many of the genera of the latter kind of fossil shells have been proposed mainly or entirely upon external characters. The rule would endanger the name *Anomalodonta*, because nothing is yet known of the pallial line and pedal muscular scars of that shell, to say nothing about the extraordinary position of the adductor impression in Mr. Miller's figure. Hundreds of cases might be mentioned of genera established upon external characters."

The misrepresentations above can not be made plainer than by quoting what was said upon the subject by me in the October number of this journal, viz.:

"The law of nomenclature, having disposed of *Megaptera*, reaches out its hand and suppresses, at least for the present, *Opisthoptera*. Because only one of the authors suggested the name with an if and a doubt, and did not himself adopt it, as plainly appears by reference to the publication in the Ohio Paleontology, above referred to, and if he had positively proposed the name, it would have fallen under the twelfth rule governing naturalists, and the reasons therefor, as follows:

'Unless a species or group is intelligibly defined when the name is given, it can not be recognized by others, and the signification of the name is consequently lost. Two things are necessary before a zoological term can acquire any authority, viz., *definition* and *publication*. Definition properly implies a distinct exposition of essential characters, and in all cases we conceive this to be indispensable, etc." Therefore;

'SEC. 12. A name which has never been clearly defined in some published work, should be changed for the earliest name by which the object shall have been so defined."

'The only generic 'characters ever given to *Megaptera*, and consequently the only ones that *Opisthoptera*, if alive, can inherit, are the cardinal teeth of an *Ambonychia*, and a long posterior wing; and the right of possession of these is dependent upon ascertaining that the lateral teeth in the posterior wing of the *Casei* is essentially different from the lateral teeth in the posterior wing of the *Ambonychia*. And if possession is ever acquired, the characters will only be sub-generic, and will include, so far as yet ascertained, but one species, whose name will then be *Ambonychia* (*Opisthoptera*) *Casei* (M. & W.)

'The genus *Anomalodonta*, having a cardinal tooth and hinge line wholly different from the *Ambonychia*, can never be affected by it or any subgenus under it. So far, then, as anything is yet known the genus *Anomalodonta* will hold its place in the zoological column, represented by at least two species, *Anomalodonta gigantea*, the type, and *Anomalodonta alata*."

Prof. White, continues:

"Unlike some other genera, *Opisthoptera* has its more conspicuous characters external, namely, its form and surface ornamentation, which when taken together are quite sufficient to distinguish it from related types, even from the broad types of *Myalina*, from which the hinge characters shown by Mr. Miller would not separate it. As Meek and Worthen, and still later, Mr. Meek alone, have fully described and illustrated these external characters of their type, they have given sufficient means for its identification, which even Mr. Miller found no difficulty in doing. To Mr. Miller's other remarks it is hardly necessary to reply."

As Meek and Worthen, and later Prof. Meek, never suggested, described or illustrated any characters for *Megaptera* or *Opisthoptera*, except by indicating the characters of an *Ambonychia*, the utter want of any foundation for such remarks will be made apparent by reference to what they said on the subject. He now comes to consider the family relations of *Ambonychia*, as follows:

"As to the affinities of *Ambonychia* with the *Aviculidæ*, which Mr. Miller rufuses to admit, on account of the equality of the valves, I need only to remark that to make such family distinctions as that proposition, would require us to divide well defined genera, some species of which would fall in one family and some in another, the genus *Inoceramus* being an example. The true (Triassic typical) *Monotis*, *Halobia*, and others are included by the highest authorities among the Aviculidæ, and yet they are equivalve. He refers to McCoy as the first to refer *Ambonychia* to the Aviculidæ, being evidently unaware of the fact that in 1833, Goldfuss in his great work, *Petrif, Germ.*, did the same. Conrad, Woodward, Brown, Dr. Carpenter, and Dr. Stoliczska all have done the same, the latter even placing it near *Avicula* in the section Aviculinæ."

The genus *Ambonychia* was formed by Prof. Hall, and first published in 1847. Goldfuss described *Pterinea carinata*, which was removed afterward to the genus *Ambonychia*. Prof. Meek discussed this matter of the family relations of these shells in his work on the Paleontology of the Upper Missouri. He divided the family *Pteriidæ*= *Aviculidæ* into three sub-families, viz.: *Pteriniinæ*, *Pteriinæ* and *Melininæ*. In the first of these sub-families he placed *Myalina* and *Ambonychia*, and he placed *Avicula* in the second sub-family. If his sub-families were raised to the grade of families, it would seem to me to be a better classification. In other words, Prof. Meek would place *Ambonychia*, *Myalina*, *Anomalodonta*, etc., in a sub-family, distinct from the *Aviculinæ*, while I infer from the above that Prof. White would not.

Cyrtoceras magister—(S. A. Miller.)

In the April number of this Journal, page 132, a new species of *Cyrtoceras* was described under the name of *obscurum* (by mistake *obscura*), since that time, I have learned that Barrande had already described a fossil, under the name of *Cyrtoceras obscurum*, and consequently, I had no right to use the word. I now propose for that species, the name *Cyrtoceras magister*.

There are two other mistakes in that monograph of the Cephalopoda that might as well be corrected here. *Orthoceras transversa* should have been written, *Orthoceras transversum*, and *Cyrtoceras ventricosa* should have been written *Cyrtoceras ventricosum*.

Note from Antioch College, by E. W. Claypole, B. A. B. S.

The Canker worm.—Anisopteryx vernata.

This destroyer of orchards reached us at Yellow Springs *from the east* about four years ago, or at least then first attracted attention. It is slowly spreading through the town. Every year a few more brown leafed apple trees in June prove its advance, this, however, is probably not its extreme western limit though how far it has advanced and as it were overlapped us, I cannot at present exactly determine. I have not been able to make a personal inspection during the month over any extent of country, and without this or the reports of some one well acquainted with the insect, such a determination is impossible, so many different species being confounded in popular accounts of "worms," "millers," etc. It would be very useful if persons living in different parts of the states, could report the appearance in their localities of this insect pest, so that its annual progress westward could be recorded.

Attempts were made by some of the owners of the infested trees to remedy the evil by the usual method, but the measures were not taken in time. Instead of papering and tarring a belt upon the trunks of the trees in October, this was delayed until March, consequently the moths which came out of their subterranean chrysalids in mild weather during the winter had ascended the trees in large numbers as was shown by the capture of hundreds, the first night after the tar had been applied.

The *Æcidium—Puccinia* question. In connection with this point it may not be uninteresting to remark that the leaves of the may apple *Podophyllum peltatum*, which three weeks ago were dotted on their lower surfaces with "cluster cups," probably *Æcidium berberidis* are noted, June 8th, thickly dotted in many places with a mildew, *puccinia* presenting under the microscope the usual appearance of two brown cells placed end to end. Each of these cells bear two or more short thick wistle-like projections. Their occurrence on the same plane may be purely accidental, but if the experiments of Prof. Oersted bear out his inference that *Aecidium berberidis* and *Puccinia granimis* are alternate forms of each other, then may this *Æcidium* which I have assumed to be *Æ. berberidis*, because the may apple and the barberry both belong to the same natural order, be also an alternate form of the *Puccinia* which has followed it.

MISCELLANY, BOOK NOTICES, ETC.

By the will of the late Mr. Charles Bodman of this city, the "Cincinnati Society of Natural History" receives a bequest of $50,000. No conditions are attached to the gift. It is absolute. Mr. Bodman was a member of the society, and by his munificence has placed it on a permanent basis, and enabled it to become one of the principal educational institutions of the city. No donation, to a public purpose, was ever more gratefully received, or more likely to perpetuate the memory of the benefactor than this one.

The cool spring and summer, and the pleasant showers and hard rains, have rendered this season unusually favorable to collectors in natural history in this latitude. The increased interest taken in geological and paleontological science, is manifested by a large increase in the number of collectors. There are, now, in this city, five times as many collectors of fossils and antiquities, as there were that many years ago, and the number will continue to increase every year. We never find a man who has studied and collected fossils at one period of his life, afterward entirely abandoning the pursuit.

A scientific association has been organized and incorporated at Richmond, Indiana. The officers for the ensuing year are James F. Hibbard, President; Wm. M. Jackson, Vice-President; L. B. Case, Corresponding Secretary; and D. H. Dougan, Recording Secretary and Treasurer. A suitable room for a museum has been leased for a term of years, and a full complement of custodians appointed. Their publications will be under the name of "Transactions of the Scientific Association of Richmond, Indiana," the first of which is a neat pamphlet of 16 pages, containing constitution, by-laws, list of members, etc.

The well at the Insane Asylum, St. Louis County, Missouri, by Prof. G. C. Broadhead, State Geologist. This well was sunk a distance of 3,843½ feet. Experiments with a Fahrenheit registering thermometer indicated at the depths of 3,127 feet 106°, 3,129 feet 107°, 3,264 and 3,376 feet 106°, 3,473, 3,533 and 3604 feet 105°, 3,641 feet 104½°, 3,728 feet 105½°, and at 3,800 and 3,837 feet 105°. The drill was highly magnetized in boring to the depth of 833 feet, but after passing that depth no farther magnetic influence was observed.

Catalogue of Lower Silurian fossils of the Cincinnati Group, found at Cincinnati, within a circuit of 40 or 50 miles. New edition much enlarged, with descriptions of some new species of corals and polyzoa. By U. P. James, Cincinnati, April 1875.

Department of the interior. United States Geological and Geographical survey of the Territories. F. V. Hayden, U. S. Geologist in charge. Bulletin No. 2, second series containing: I. Monograph of the genus *Leucosticte* (Swainson); or gray crowned purple finches by Robert Ridgeway. II. The cranial and dental characters of *Geomydæ* by Dr. Elliott Coues. III. Relations of insectivorous mammals by Theodore Gill. IV. Report on the natural history of the United States Geological and Geographical Survey of the Territories 1874, by Ernest Ingersoll. Bulletin No. 3, containing topographical and geological report on the San Juan Country. Bulletin No. 4, containing "Notes on the Surface features of the Colorado or Front Range of the Rocky Mountains," by F. V. Hayden. "*Tertiary Physopoda* of Colorado" by Samuel H. Scudder. And "Outlines of a natural arrangement of the Falconidæ" by Robert Ridgeway. Miscellaneous publications, No. 1, giving a list of elevations; and Miscellaneous publications, No. 6, giving Meteorological observations.

Geographical explorations and surveys west of the 100th Meridian. First Lieut. Geo. M. Wheeler, corps of engineers in charge. Systematic catalogue of Vertebrata of the Eocene of New Mexico, collected in 1874, by E. D. Cope, A. M. paleontologist.

THE NATIVE RACES OF THE PACIFIC STATES. By Hubert Howe Bancroft. Vol. II, Civilized Nations. D. Appleton & Co., N. Y., Publishers. Price $5 50.

Mr. Bancroft has already shown us enough to justify the warmest praise of his work as a whole. Bringing to bear upon a large and varied mass of materials, collected at great expense and labor in different countries—a wise, painstaking and comprehensive discrimination—he has evolved a work of lasting merit and exciting interest. His book is not a mere encyclopedia of information concerning the early American races. The varied and varying phases of their life, manners, customs, ideas, and surroundings are so fully and vividly depicted, that the reader is led into their very spirit and reality. The faded hues of the ancient civilization are again restored, and the figures, instinct with life, move before the imagination in their accustomed spheres, as parts of the unique system, which withered at the touch of the Conquistadores, three centuries and a half ago.

The present volume treats fully of the Maya and Nahua branches of aboriginal culture—the last being most fully known to us through the Aztecs of ancient Mexico, although the Maya nations of Yucatan, Chiapas and Gautemala were more advanced in knowledge of arts and general civilization.

Unfortunately, the evidences of the more elevated, and to us, more interesting, features of this culture, were almost wholly destroyed by the Spanish ecclesiastics in their blind bigotry and zeal, Mr. Bancroft has, however, succeeded in collecting a large amount of information on these points, which is exceedingly valuable. He shows, that beyond the mere manual dexterity and skill in manufactures, which excited the wondering praise of the Spaniards, the Mexicans possessed an advanced literary and artistic culture, which the rude soldiery of Cortes, and the fanatical priesthood, were entirely incapable of appreciating, and hence, have given us but meager and imperfect accounts.

In the palmy days of the Chichimec empire and indeed down to the coming of the Spaniards, an academy or council at Tezcuco controlled all branches of art among the Nahuas, especially poetry, oratory, history, painting, and lesser arts. Every teacher of the young was required to have a certificate of his qualifications from this council, and before it the pupils were brought for examination. Every literary work was subject to its revision and at certain sessions, poems and historical essays were read by the authors, new inventions exhibited and rich prizes awarded for excellence in any branch of learning. Of their literary works few fragments remain; but these breathe an elevation of sentiment and dignity of style not unworthy a place beside the productions of ancient Greece.

The error of considering the picture writings of the Aztecs as a test of their general knowledge of art is clearly shown; as in these a conventional style was absolutely requisite in order to make them available as records.

Mr. Bancroft is also led to hope after full examination that future study will unravel the secrets hidden in their sculptured delineations, and picture-writings, and yield a conclusive solution of those ethnological problems, which have so long baffled inquiry.

The succeeding volumes will treat more fully of their antiquities, religion and language, and discuss the various conclusions and theories suggested by scholars as to the origin and growth of these nations and their civilization.

The work forms one of the most valuable contributions of modern times, to the science and literature of this subject, and should have an honored place in every well selected library.

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Teneina of Colorado. BY V. T. CHAMBERS.

Manitou, September 1, 1875.

The following list comprises all the *Teneina* that I have met with in Colorado since July 20th. The species do not appear to be numerous, but the individuals of some of them swarm about the food plants of the larvæ. They were captured, or bred, along the course of Clear Creek, and in Middle Park, and a few at this place; the altitudes given are the highest at which the species were observed. The flora of the mountains is, much of it, new to me, and in the absence of all books, it has been impossible, sometimes, for me to determine the species of plants on which larvæ feed:

GELECHIA—*G. gallæsolidaginis* (?)—Riley.

Bred from galls gathered on the banks of Grand River, in Middle Park; altitude, 8,500 feet. I have no specimens of *G. gallæsolidaginis* here to compare with, nor any description, and I am not very certain that my specimens belong to that species. If they do, they are like their food plant, dwarfed by climatal conditions, and they are much less distinctly marked, some of them being simply brown, with the markings scarcely discernable, though others are more distinctly marked. The gall, as it is described by Prof. Riley, and as I have found it in Kentucky, is oblong, and sometimes it is so here, but usually, it is much more rounded, and sometimes might be mistaken for that of *Trypeta solidaginis.*

G. rosasuffusella, Clem.

Taken at Manitou, at light, Aug. 30; altitude, 6,100 feet.

G. 10 *maculella* (n. sp.)

This species, of which I have but a single captured specimen, reminds one as to ornamentation of *G.* (*Taygate*) *difficilisella*, Cham. It is, however, larger, having an *alar. ex.* of about seven lines, Hind wings not excised beneath the tip; palpi slender, simple with the third joint nearly as long as the second. Palpi and forewings pale ocherous, almost white. There is a brown spot on the outer surface of the second joint of the palpi at the base, and a small one also on the base of the third joint, which has also a brown annulus before the tip. Base and tips of the forewings rich brown, also two costal spots of the same hue, one of which (the smallest) is before the middle and the other behind it; there is also a dorsal spot of the same hue oppossite to the first costal one; hind wings and cilia of both pair pale grayish; face yellowish; vertex fuscus; thorax rich brown; upper surface of the abdomen fuscus; anal tuft ocherous; hind legs marked with brown. Taken at Spanish Bar (mouth of Fall River), Clear Creek, July 28th. Altitude, 7,800 feet.

G. 4 *maculella* (n. sp.)

Hind wings not excised beneath the tip; second joint of the palpi with a large brush beneath; dark brown; the forewings have four obscure darker brown spots, two of which are on the fold, the first one being the most obscure, one on the disc, and one at the end of the cell; legs annulate with ocherous. *Al. ex.* 8 lines. Taken at the light, August 6—a single specimen—Spanish Bar.

G. ribesella (n. sp.)

Palpi brown, the second joint brush-like, tipped with pale yellowish; third joint nearly as long as the second; head and thorax roseate tinged with pale yellowish; antennæ brown above and dotted with white beneath; forewings rich brown, a little dusted with white and pale roseate along the costal margin; and with a white spot on the disc, margined both before and behind by a spot of darker brown than the general hue, there is another smaller white spot nearer to the base, and a white fascia before the cilia, widest on the dorsal margin; cilia of forewings bright roseate, in some lights almost brick red, and somewhat dusted with brown; behind the fascia the wing is darker than it is before it, except upon the disc before and behind the white spot, and to the unaided eye, the whole wing sometimes appears to be suffused with roseate; under surface of the abdomen whitish, densely dusted with brown; legs brown, annulate with roseate and whitish. *Al. ex.* 7 lines. It is one of the prettiest species of this genus. The larvæ is straw color with six longitudinal roseate stripes, two dorsal, and two on each side. It feeds upon the leaves of the wild Rocky Mountain red currant as high up as 8,000 feet, and possibly much higher. It folds the leaf downward from each side and the tip, and lives within the fold. The folded leaf is difficult to distinguish from that of a species of *Gracilaria*, which feeds in the same manner on the same leaves, but which I did not succeed in rearing—Spanish Bar.

G. 8 *maculella* (n. sp.)

Hind wings a little excised beneath the tip; second joint of the palpi a little brush-like, third more than half as long as second; white dusted with dark brown; antennæ annulate with brown. The fore-wings have a brown spot on the dorsal margin near to the base, which is also brownish, and also a large rust red spot on the disc before the middle which touches a brown costal spot placed just before it, there is another rusty red spot at the end of the disc, and a rather dense small patch of dusting before the costal cilia, and one also before the dorsal cilia; hind wings pale grayish fuscus; abdomen and anal tuft silvery; legs densely dusted with brown; and tarsi brown, annulate with white. *Al. ex.* nearly one-third inch. Hot Sulphur Springs, Middle Park. Altitude, 8,500 feet.

G. albimarginella (n. sp.)

Palpi simple; brown; second joint of the palpi mixed with white; third joint white at base and tip; dorsal margin of the forewings, from base to cilia, grayish white. *Al. ex.* two-thirds inch. In company with *G. gallæsolidaginis*, Riley, on Grand River.

The species of *Gelechia* are much less numerous in this region than in other parts of the United States, as compared with species of other genera.

PLUTELLA.—*P. cruciferum*, Auct.

This ubiquitous species was taken at an altitude of 11,500 feet near Berthouds Pass.

ŒCOPHORA.—*Œ. boreasella*, Cham.

This species also has a wide range of altitude as well as latitude and longitude. It was first described from a specimen sent to me from London, Ontario, by Mr. Saunders; afterwards I took a specimen in Kentucky, at an altitude of about 1,500 feet, and I have found it on Bellevue Mountain, in the neighborhood of Idaho Springs, at an altitude of about 10,000 feet.

Œ. 4 maculella (n. sp.)

The apical half of the antennæ is broken off in this specimen before me and the insect has so much the appearance of a *Gelechia* that I hesitate a little to place it in this genus, notwithstanding the slender palpi and the form and neuration of the hind wings.

Rich brown; antennæ annulate with white; forewings each with four white spots, two costal and two dorsal; the first dorsal is near the basal one-fourth, the second is behind the middle (just before the cilia); the first costal is opposite to the space between the first and second dorsal, and the second costal is a little behind the second dorsal. Hind wings and cilia of both pairs greyish fuscus. *Al. ex.* over one-half inch. Taken July 28th, at Spanish Bar. Altitude, 7,800 feet.

GLYPHIPTERYX.—*G. montisella* (n. sp.)

A very variable species illustrating the insufficiency of the number and position of the white and silvery streaks on the forewings as specific characters in this genus. Taken in great numbers feeding on the flowers of *Heliopsis* and *Helianthus* at Spanish Bar. Altitude, 7,800 feet. Two or more species might easily be made of single captured specimens, but when the individuals of a species are so abundant as they are in this case, and when all the variations found among them are frequently found in the wings of the same insect, no room is left to doubt that we have only a single species.

Second joint of the palpi white at the base, followed by alternate annulations of white and dark brown, its apex being white; third joint with a dark brown annulus followed by a white one and with the apical half dark brown with a longitudinal white line on each side. Head antennæ and forewings to the streaks dark brown, with less of the leaden hue than is found in *G. exoptatella*, the remainder of the wing pale golden or straw color, according to the light, and containing sometimes five, sometimes six and sometimes seven white costal streaks; sometimes five on one wing and six or seven on the other. The first is like that of *exoptatella* and *Haworthana* but narrow; it is dark margined both before and behind; the second is opposite to and usually confluent with the first dorsal streak which is of nearly the same size but is a little wider on the margin though narrower rather than *Haworthana*; together these streaks usually form a fascia strongly angulated behind; then follow two other slightly oblique costal streaks dark margined all around and opposite to each of these is a dorsal metalic violaceous spot the first of which (*i. e.* the second dorsal streak) is placed immediately before the cilia, (this third costal is frequently absent). Between the fourth costal streak and its opposite dorsal spot is another metalic violaceous spot. The fifth costal streak is opposite to the fourth dorsal metalic spot, and between them is a larger metalic violaceous spot, which is sometimes confluent with the fifth costal streak, and sometimes this fifth costal streak is only represented by a very small violaceous metalic spot while sometimes it is absent entirely. The sixth costal streak is sometimes short and sometimes long enough to almost touch its nearly opposite dorsal metalic spot which is a little elongate, lying along the base of the cilia and is sometimes confluent with its predecessor, the fourth dorsal spot. The sixth costal streak is a little behind the fifth dorsal spot, and there is a metalic spot between them with which the sixth costal is sometimes united. The seventh costal is before the apex, a little hooked backwards and almost unites with it, opposite the sixth dorsal spot which is also hooked backwards. (When any of the streaks are indistinct or absent it is always the third or the fifth costal ones or both, and sometimes one or both of them is present in one wing and absent in the other of the same insect). There is no dark brown streak in the costal cilia projecting backwards, as in some other species, and the cilia have their basal half brown and the remainder silvery, but the dark brown is interrupted by the last dorsal white streak. Under surface and legs rich dark brown; the hind tarsi annulate with white; each segment of the abdomen beneath margined behind with silvery white, and anal tuft whitish. *Al. ex.* averaging about five lines. Season, August.

In company with the multitude of specimens, from which I have prepared the foregoing description, of what I regard as a single species, was a single specimen having the base of the dorsal margin of the forewings white, and the first dorsal streak forming a large square spot with a tooth projecting towards but not touching the second costal streak. I regard it also as belonging to the same species.

ARGYRESTHIA.—*A. gœdastella*, Auct.

Only known heretofore in this country by a single specimen sent to me by M. Bélanger from Quebec, this species occurs in the greatest abundance among the leaves of the 'Black Alder' (*Alnus* sp?) along Clear Creek, and on Grand River, in Middle Park, reaching an elevation of at least 9,000 feet, where still water freezes nearly every night in August.

COLEOPHORA.—*C. luteocostella* (n. sp.)

Second joint of palpi with a small projecting tuft; basal joint of the antennæ enlarged. Dark greyish ocherous, or perhaps as correctly, dark greyish drab, and in some lights brownish; basal joint of the antennæ and the annulations of the stalk yellowish ocherous, and a narrow streak of the same hue along the costal margin of the forewings, which are a little dusted with brown especially toward the apex; abdomen with a leaden hue, sparsely dusted with ocherous on the under surface and the tuft ocherous. In many specimens which were taken at the same time, the light color of the costal margin is very narrow being sometimes confined to the extreme costa or even entirely absent near the base of the wing and sometimes the brown dusting is very dense. *Al. ex.* about seven lines. It occurs in the latter part of July and in August in swarms in the grass at Spanish Bar. Altitude 7,800 feet, and a single specimen of it, or of an allied species, was observed but not secured at an elevation of over 11,000 feet near Berthouds Pass.

C. sparsipulrella (n. sp.)

Antennæ simple. Second joint of palpi with a minute projecting tuft. White with a faint appearance of ocherous dusting on the forewings. *Al. ex.* $6\frac{1}{2}$ lines. Spanish Bar, in August.

LAVERNA.—*L. albella* (n. sp.)

Snowy white; each wing with about fifteen brown scales scattered over the apical half, some of which are in the cilia. *Al. ex.* scarcely one-half inch. Spanish Bar, August 3d; a single specimen. Probably not a true *Laverna* as the palpi are rather small and more like those of *Phyllœnistis.* The vertex is short and the antennæ and wings, including the neuration, are those of *Laverna.*

L. albapalpella (n. sp.)

Palpi, head and thorax, white, the vertex stained with purplish fuscus, and base of second joint of the palpi brown on the outer surface; antennæ brown; forewings brown mixed with purplish and ocherous; the dorsal margin of the forewings, from the base to the middle, is white, the brown color of the wing projecting into the white but not dividing it into two spots. There is a small white spot about the middle of the costal margin, and a white fascia placed about the apical one-fourth, is widest on the costa and contains a brownish spot about its middle, and there is a confused series of whitish spots around the apex at the base of the cilia which are yellowish white; hind wings pale greyish fuscus; abdomen brown, each segment margined behind with silvery white; and tuft yellowish, legs dark brown annulate with white. *Al. ex.* a little over one-half inch. A single specimen captured on flowers of *Heliopsis levis* at Spanish Bar, August 3d.

L. grissella (n. sp.)

Second joint of the palpi with spreading scales at the apex beneath. Head and second joint of the palpi pale ocherous, almost hoary, with greyish brown intermixed. Third joint of the palpi greyish brown with an ocherous annulus at the base and one at its middle and the tip ocherous; Antennæ dark brown, with the basal joint a little enlarged and having some short bristle like scales projecting downwards over the eyes. Thorax, on the upper surface dark grisseous (pale gray over laid with dark brown). Base of the dorsal margin of the forewings a little paler than the thorax, the forewings, otherwise dark brown, obscurely streaked and somewhat suffused with yellowish ocherous; the dark brown hue projects into the pale grisseous of the basal dorsal margin but does not divide it into two portions; the pale grisseous hue extends nearly across the wing at the base, and is margined behind by an oblique streak of raised scales which is nearest to the base on the *costal* margin, but does not quite touch either the costal or dorsal (?) margin, these raised scales form a small ocherous tuft at the point where the dark hue projects into the pale grisseous. About the middle of the wing length is a precisely similar and parallel oblique row of raised scales which margins the pale grisseous color behind with a similar tuft. (A very little denudation removes all these raised scales except the tufts). At about the apical fourth is another similar oblique streak of raised scales but which differs from the others by being nearest to the base on the *dorsal* margin and which is much more oblique than either of the others approaching the costal margin just before the apex. Abdomen and anal tuft dark grisseous above with purpleish reflections. In the general color it resembles somewhat *L. cephalanthiella*, Chamb., but it has no close affinity with it. The cilia are pale fuscus, those of the apex dotted with hoary and with two brown hinder marginal lines, one about the middle and the other at their apex. Legs and tarsi brownish gray the tarsi annulate with white. *Al. ex.* over one-third of an inch. Taken at Spanish Bar. Three specimens at light in August.

L. grandisella (n. sp.)

A single specimen of this fine species came to the light at Spanish Bar, August 6th. It has an *alar. ex.* of a little over eight lines. Second joint of the palpi enlarged with spreading scales toward its apex; palpi brown above, ocherous beneath; head, antennæ and upper surface of thorax brown, the thorax becoming ocherous toward the tip; forewings brown, some little dusted with ocherous, and with the dorsal margin gray to the fold. In this gray portion is a large dark brown raised tuft which touches the fold about the middle, and is margined behind with ocherous scales, and there is another tuft like it at the beginning of the dorsal cilia; on the costal margin, just before the cilia, is an oblique streak of dense white dusting. The apical part of the wing is more ocherous than brown, and is dusted with white and brown; cilia grayish, dusted towards the base with brown and white, and with a brown hinder marginal hue about their middle; the abdomen is dark blueish-brown above, with the third, fourth, fifth, and last segments marked by two ocherous spots, and the sixth and seventh having some ocherous scales intermixed; anal tuft ocherous; hind wings rather dark gray, a little darker than the dorsal margin of the forewings; each segment of the abdomen, after the first two, in addition to the above mentioned spots, is margined behind with white, and on the under surface the abdomen is brown, and each segment is margined behind with white; legs brown, the hinder pair annulate with ocherous. After being chloroformed the specimen deposited a great many eggs, which are almost uniform, and marked by five ridges which follow the outline of the shell, and having a length of about $\frac{1}{50}$th, and heighth of about $\frac{1}{100}$ of an inch.

The food plants of the larvæ of these species are not known. Finding so many species in one locality, and knowing the partiality of many species of the genus in the larval state for *Œnothera* and allied plants, I searched these plants, which are very abundant at Spanish Bar, carefully for the larvæ, but without any other success than finding in a very small mine, in a leaf of *Œbiennis*, two young larvæ, which I believe to be those of *Laverna*, but which afterward died.

BEDELLIA—*B. somnulentella*, St.

I have not met with this species, but have found at Manitou Springs (altitude, 6,100 feet), a few of its mines in leaves of Morning Glory (*Ipomea* sp. ?).

COSMOPTERYX—*C. montisella* (n. sp.)

Rich brown, but faintly tinged with green; second joint of the palpi with three longitudinal white lines, one of which is on the under-side, one on the outer and one on the inner surface; third joint with a white line beneath and one above; basal joint of the antennæ with a white line above and one beneath, these lines also extend along the stalk for more than half its length, the remainder of the stalk (though a little rubbed in the single specimen before me) appears to be annulate with white, and with two large white annulations before the apex. The head is marked with three white lines, one being over each eye, and one on the vertex, the latter not extending down on the face; tongue whitish; thorax with four white lines, two of which are on top and one on each side, the two middle ones also being each continuous with a white line which extends along the dorsal margin of the forewing nearly to the fascia, and the two outer ones are each continuous with a white line which extends along the costal margin for a short distance, and then leaving the margin, passes obliquely backward to the fascia; (this is true only of one wing in this specimen, in the other wing it does not reach the fascia, being much abbreviated, and perhaps, in the wing, where it seems to reach the fascia, it is more properly described as being also abbreviated and not reaching the fascia, but as becoming confluent with a discal oblique streak which does extend to the fascia on the one wing, but is entirely absent on the other.) At about the basal one-fourth of the wing length are two other short oblique discal white streaks, one above, the other beneath the fold; the fascia placed just behind the middle is of an orange color, and is widest on the costal margin when it is produced backward along the margin, immediately before it is a transverse streak of smooth raised silvery scales, which does not quite touch the costal margin, and is separated from the orange fascia by a narrow line of black scales; behind the orange fascia, and separated from it by a narrow line of blackish scales, is a smooth raised tuft of silvery scales on the dorsal margin, and there is a similar tuft on the costal margin behind the produced portion of the fascia also separated by a blackish line. The wing behind the fascia is brown, with a short silvery dorsal line, and a similar one at the apex; hind wings and cilia pale grayish fuscus; abdomen of the general brown hue, with a longitudinal band or wide line of orange-yellow extending along the top of all except the last two segments, and each segment margined beneath and on its sides with silvery; and tuft silvery; legs and tarsi brown, the hinder pair annulate with silvery. *Al. ex.* a little over one-half inch. Spanish Bar, August 1. Not surpassed in beauty by any species of this fine genus.

Gracilaria.

Two species of this genus feed upon leaves of the "Black Alder" (Alnus sp.) in great numbers. The one which I describe as *G. alnivorella* makes a short narrow *phyllœnistis*-like mine on the upper surface in its earlier stages, and after leaving the mine it rolls the leaf downward from the side and passes the pupa state in a compact whitish cocoon under the edge of the leaf which is curled very tightly down over it. The other species which I describe as *G. alnicolella*, in its early stages makes a small tentiform mine on the under side of the same leaves, and afterward, leaving the mine, it rolls the leaf downward from the tip, and passes the pupa state under a dense greenish-yellow cover or web ribbed or folded along the middle.

G. alnivorella (n. sp.)

The antennæ and the palpi are rather shorter and thicker than is usual in *gracilaria*, Gray. Maxillary palpi whitish, with dark gray or brownish spots; face, third joint of the labial palpi and apex of the second joint brown; antennæ grayish-brown faintly annulate with gray; thorax and abdomen dark gray; patagia a little paler; forewings gray, marked with numerous small brown spots, which are usually arranged rather irregularly, but which sometimes seeming to form about five longitudinal rows, one of which extends along each margin, and usually, one of the spots on the dorsal margin, and one before its middle, three beyond the middle of the costal margin, and one at the apex, are larger than the others, but in a series of specimens, the spots are found to vary, both in position and size; cilia of the forewings gray, those around the apex densely dusted with brown, and with a narrow pale ocherous hinder marginal line about the middle; hind wings and cilia paler gray; fore legs dark gray, annulate with whitish with the femora pale gray at the base, and mixed with reddish ocherous on their outer surface; intermediate legs dark gray, annulate with whitish, with the tarsi pale gray; hind legs pale gray, marked with dark gray, with the tibia and tarsi paler and annulate with whitish. *Al. ex.* 8 lines.

G. alnicolella (n. sp.)

Pale brick red with strong roseate or purplish reflections in some lights; antennæ silvery white, each joint with a brown dot on the upper side; tarsi silvery white, faintly annulate with fuscus at the joints; abdomen and anal tuft pale straw yellow, the upper surface a little suffused with fuscus. *Al. ex.* eight lines. A more graceful and slender insect than the preceding.

Both of these species are found in great numbers along the course of Clear Creek and Grand River to an elevation of at least 9,000 feet, and I have also met with their larvæ along the Fontain-qui-bouille near Colorado Springs.

G. acerifoliella (n. sp.)

Palpi, head, antennæ, thorax and forewings ocherous, with brown intermixed, the antennæ annulate with dark brown, and the thorax sometimes without the brown dusting. There is a brown streak near the base of the forewings passing obliquely backwards and reaching the fold, a brownish spot on the dorsal margin, not far from the base and the middle of the wing, is suffused and sprinkled with brown, the brown becoming much more distinct toward the apex; there is a row of brown dots along the costal, and one along the dorsal margin to the cilia, which are sprinkled and tipped with brown, the dusting indicating these indistinct hinder marginal lines, the first of which is about the middle and the third near the tip. The wings show strong purple reflections and in some lights the ocherous colors become distinctly golden, but there is a considerable amount of variation in the intensity and amount of the brown and ocherous hues, some specimens having so large a portion of the wing strongly suffused with brown that they would perhaps be best described as brownish ocherous with a pale ocherous costal triangle truncate at the fold, and produced a short distance back on the costa with about five brown costal spots in the triangle. *Al. ex.* about $\frac{5}{8}$ inches.

The larvæ folds the leaf of the bush maple (*Acer.* sp?) downwards, first from one side, then from the other, and then from the tip. Hab. Clear Creek. Altitude as high as 9,000 feet.

G. thermopsella (n. sp.)

This species is closely allied to *G.* (*Parectopa*) *robiniella* Clem., *G.* (*Parectopa*) *lespedezæfoliella* Clem., *G. salicifoliella* Chamb. The larvæ and mine and larval habits are very similar to those of *G. robiniella*, but the mine is less regularly digitate. It mines the upper surface of the leaves of a vetch (*Thermopsis montana?*) Under surface of the body white; legs dark gray brown the tarsi annulate with white. Outer surface of the second joint of the palpi dark gray brown, inner surface whitish, third joint whitish with a brownish annulus before the tip. Head white suffused with grayish on the vertex; antennæ dark gray brown annulate with white; thorax white; forewings with the dorsal margin white, the remainder of the wing gray or greyish brown and dark brown along the disc; the dark brown of the disc is divided into three distinct spots by three short white streaks emitted from the white dorsal margin, and which pass a little obliquely backwards, the first placed before the middle, the second about the middle, and the third behind it, and behind these three are about three white dorsal spots or streaks, the last of which is just before the apex and is concave towards it. In the grayish part of the wing are five white costal streaks; the first of these is long and narrow, beginning about the basal third of the wing length and passing obliquely backwards until it almost touches the white of the dorsal margin in the apical part of the wing, the second is wider and much shorter, the third shorter and narrower than the second, but both oblique; while the fourth is still shorter, and is nearly perpendicular to the margin, and the fifth presents a concave edge towards the apex, and is opposite to the last dorsal streak, which it almost touches just before the apex, and behind it is a small white spot in the cilia. The apical third of the wing is somewhat dusted with white, and the apical spot is dark brown, and is large, extending to the last costal and dorsal streaks (or perhaps it would be more correct to say simply that the apical part of the wing, behind these last streaks, is dark brown). Costal cilia brown; dorsal cilia white with a wide dark brown hinder marginal line behind their middle; ciliary 'hook' dark brown, margined beneath with white. Upper surface of the abdomen dark brown. *Al. ex.* three-eighths inch. Spanish Bar.

As already noted (*see Gelechia ribesella*) there is a *Gracilaria* larvæ which feeds on the leaves of the wild red current, which I did not succeed in rearing.

G. populiella (n. sp.)

Yellowish ocherous, with strong purple reflections, (ocherous or purple, according to the light.) The costal triangle is only indicated by a paler yellowish hue about the middle of the extreme costal margin, which is also sprinkled with brown dots, and there is a row of brown dots extending along the middle of the wing, from near the base to the tip, and on one wing there are two or three small ones beneath the fold; cilia grayish brown with the tips brown, and a dark brown hinder marginal line beyond the middle. Hind wings and cilia shining, grayish fuscus; abdomen of the same hue with the hind wings. In the single specimen before me the tibia and tarsi of the forelegs are broken off, the tarsi of the middle pair are white, faintly annulate with fuscus at the joints, and the tibial spurs are white; hind tarsi and tibia whitish stained with fuscus; the legs are a little more brownish than the forewings. Antennæ brown, annulate with pale yellowish. *Al. ex.* 7 lines. The larva feeds on the leaves of poplars, folding the edge downwards, and feeding and perpetuating under it. This specimen was taken at an elevation of about 9000 feet, near Berthouds' pass. In the same leaf, on the underside, was a small tentiform mine, in which the larva probably passed its first stages.

ORNIX—*O. puinrosella?* Chamb.

I have not seen this species in any of its stages, but have found its mine in the bush wild cherry of the mountains, both on Clear Creek, at Spanish Bar, and on Fontain-qui-Bouille, near Manitou. Altitude 8000 feet.

LITHOCOLLETIS—*L. alnivorella* (n. sp.)

Palpi and antennæ rather short for this genus, and tuft on the vertex, also small; face, palpi, under surface of thorax and abdomen and the legs silvery, the palpi a little darker on the outer surface; antennæ and tuft silvery fuscus, or perhaps as correctly ash-brown; upper surface of thorax and forewings egg yellow, varying to golden with change of light. There is a short basal, silvery white streak along the dorsal margin of the forewings, and a longer median basal streak of the same color, and dark margined towards the costa. A silvery white fascia immediately before the middle, posteriorly obtusely angulated about the middle of the wing, and dark margined before, the dark margin becoming more diffuse along the dorsal margin, where it is produced forwards until it meets the basal dorsal white streak; the point of the angle of the fascia is sometimes margined behind by a small dark-brown spot, and the fascia is widest on the dorsal margin; just behind the middle is a costal silvery white streak, and opposite to it is a dorsal one, both strongly dark margined before, and both pointing a little obliquely backwards, this dorsal streak is placed immediately before the cilia, and a little further back is a small triangular dorsal silvery spot, dark margined before; opposite to the space, between these two, is a straight silvery costal streak, also dark margined before, which sometimes bends backwards and unites with the second of the dorsal streaks referred to above, whilst its dark margin bends forward and unites with the dark margin of the first one; further back is a third costal streak which is small, straight and dark margined before. Apical spot triangular and dark brown; cilia silvery fuscus; hind wings and cilia a little darker than the cilia of the forewings. Abdomen shining bluish black on its upper surface. *Al. ex.* less than one-third inch. Spanish Bar. The larva is cylindrical and makes a large tentiform mine on the under surface of the leaves of an Alnus, (sp. ? not the black alder.)

L. salicifoliella? Clem. and Chamb.

This species has heretofore been bred only from willow leaves I believe; while these specimens were bred, both from willows and poplars, and the mines were much larger than those from which I bred *salicifoliella* in Kentucky. I have little doubt, however, that it is the same species. If not, it is very closely allied to *salicifoliella.* I have gathered these mines at more than 10,000 feet above sea level, more abundantly than in Kentucky at 700.

LYONETIA—*L. alniella* (n. sp.)

This species occurs by thousands along Grand River, Clear Creek, Fall River and Fontain-qui-Bouille, in all its stages, up to 9000 feet altitude. The larva is gregarious, four or five being usually found in a single mine. It is the only American species of the genus of which the mine is known. I am acquainted with a larva which mines the leaves of the red wild plum in Kentucky, and which, I believe to be that of a species of this genus, but I have never succeeded in rearing the wings from it; it makes a linear crooked mine ending in a small blotch, and leaves the mine to pupate; but all my specimens died soon after leaving the mine. The mines of the European species, I believe, resemble somewhat that in the wild plum, but the mines of this species are very different, they begin as a small brown blotch at the side of a leaf, and frequently spread over more than one-third of the surface, and it is not unusual to find "black alder" bushes with a fourth of their leaves curled and browned by these blotches. After leaving the mine its habits are those of the species already known in Europe, the pupa being suspended among threads of silk spun by the larva so as to slightly curl a leaf.

Snow white; antennæ brownish, except the base; forewings with an oblique grayish brown streak about the basal fourth of the dorsal margin, and another about the middle, and both pointing a little obliquely backwards; dorsal margin, along the base of the cilia, grayish brown, ending in an oblique streak which passes down into the apical part of the wing, and further back are two other small oblique dorsal streaks; beyond the middle of the costal margin are six oblique grayish brown streaks, the first three pointing backwards, and the others pointing forwards a little, but being nearly perpendicular to the margin. Apical spot blackish, circular, with two diverging grayish brown streaks behind it in the cilia. Frequently the costal and dorsal streaks are small and distinctly separated, but more frequently they are confluent in the apical part of the wing, which thus becomes grayish brown instead of white; the extreme costa is sometimes gray brown to the base, and so is the tip of the thorax, and occasionally a specimen is bred which has the entire thorax and forewings deeply suffused with grayish brown. *Al. ex.* 5 lines.

PHYLLŒNISTIS—*P. populiella*, Chamb.

Common, up to more than 10,000 feet.

P. ampelopsiella, Chamb.

Manitou up to 8000 feet or more.

Eurynome—*Gen. nov.*

Allied to *Phillonome*, but differs from it by having the maxillary palpi not developed; it differs from *Bucculatrix* by having the labial palpi developed. The hind wings are wider than those of *Bucculatrix* and *Phillonome*. The neuration of *Phillonome* differs (in the forewings) decidedly from that of *Bucculatrix*, to which it is, in many respects, allied, and resembles that of *Elachista*, and scarcely differs from that of *Thuira*. Having but a single specimen of the species described below, I have not examined the neuration. It has both pairs of wings linear lanceolate, the hinder pair narrower than the forewings, with the costa arched to the middle, and the dorsal margin regularly curved; widest just before the middle, and thence narrowing rapidly to the apex, cilia long; tuft on the vertex large, extending down between the antennæ as in *Phillonome*; labial palpi and tongue nearly as in that genus and in *Lithocolletis;* face smooth, rounded, not much retreating; the ends of the antennæ are burned off by the lamp in this single specimen, and the basal joint is clothed with an eye cap as in *Bucculatrix*, but smaller; eyes moderate. *Ocelli?*

E. luteella (n. sp.)

Head, eye caps and palpi white, the latter stained with yellowish; thorax white above, becoming more yellowish towards the tip; patagia and forewings pale saffron yellow, or luteous irregularly and somewhat indistinctly marbled with whitish anastomosing streaks and spots, which are not very clearly outlined. To the unaided eye the wing appears pale, saffron or luteous indistinctly marked with paler streaks or spots; one of these pale spots is on the disc within the basel fourth, and passes obliquely back to the fold and across it, to near the middle of the dorsal margin, when it becomes more distinct; another begins on the costa about or immediately before the middle and after leaving the margin again curves back to it, enclosing a small saffron yellow spot on the costa, it is also connected with the first named streak beneath the fold by a very short branch; or perhaps, as correctly, both of these streaks may be described as one thus: beginning on the disc and crossing the fold to the middle of the dorsal margin, and thence obliquely back to the costal margin just before the cilia, sending off above the fold a branch to the middle of the costal margin; but, as stated before, these whitish marks are not distinctly outlined; there is, however, a tolerably distinct white spot on the dorsal margin before the cilia, which is obscurely connected with a smaller one a little further back at the base of the costal cilia. Abdomen and anal tuft, more decidedly yellowish on top. *Al. ex.* quarter inch. A single specimen taken at light at Spanish Bar, July 4.

The Past and Coming Transits and Artic Explorations. By RICHARD A. PROCTOR.

The materials obtained during the recent transit of Venus have been gathered together, and though many months must elapse before the definite solar distances to which they point can be ascertained, we already possess the means of forming an opinion as to their general value. The result is not altogether that which had been anticipated by any among those who were interested in the preliminary arrangements and preparations; though, on the whole, it would appear that the astronomers of America formed the justest anticipations respecting the probable course of events. I am not, of course, referring here to accidental circumstances, such as the weather at this or that station. It must be clear that the best laid plans were liable to be defeated by conditions of weather; for though some of the stations were placed in regions where the weather probabilities were exceedingly favorable, and others unfortunately (but necessarily) in regions exposed to almost continual storms, yet nothing could be *confidently* predicated, even respecting these stations, and far the greater number had simply the ordinary chances of fair or foul weather. It happens, indeed, that of the two most favored regions, Egypt and New Zealand, the former barely sustained its reputation (the sun at some stations only just clearing a cloud-bank in time to be seen), while the latter had worse fortune than any other region of like extent. On the other hand several stations where bad weather was regarded as too probable—as St. Paul's Island, Auckland Island, and Kerguelen Land—had very favorable weather. I may notice, in passing, that even as respects the manner in which weather probabilities were dealt with, there was a wide difference between the American and our English manner of acting. For we find that the official astronomers responsible for the

English plans considered the unfavorable weather likely to prevail over most of the more suitable southern regions was a sufficient reason for having *fewer* southern than northern stations. The American astronomers held just the contrary opinion. "From all the reports," says Professor Newcomb, the Chief of the Washington Observatory, "it was found that the chances of good weather were much better in the northern than in the southern hemisphere; therefore, instead of sending an equal number of parties North and South, it was determined to send three to the northern and five to the southern hemisphere."

But it was in the actual observation of the phenomena of the transit that circumstances were noted which most significantly affect the value of the various methods. These circumstances I proceed now to consider, as on them must not only depend the opinion we are to form respecting the arrangements which should be made for the transit of 1882, but also the value we are to attach to the results secured last December.

In the first place, it will be remembered, that though doubts were expressed in many quarters as to the possibility of determining the moment of internal contact with great accuracy, the doubts so expressed were based chiefly on a phenomonon called usually the "black-drop." It had been supposed that the greater part of the error in the determination of the solar parallax from the transit of 1769, had arisen from the difficulty caused by the "black-drop." Some observers were assumed to have taken for the moment of true internal contact the instant when the edge of Venus seemed to separate from the sun's at ingress, or to join the sun's at egress—a sort of dark ligament suddenly breaking in the first case, and as suddenly forming in the second case. Other observers were assumed to have judged when the outline of the undisturbed part of the planet's disc belonged to a circle which, if complete, would have just touched the sun's edge. The interval between the first kind of contact and the second, or between the real contact and apparent contact, was assumed to have a constant value—seventeen seconds. This done, and the observations passed through what Leverrier has called the "grist-mill" of the method of least squares, there came out a result agreeing very well with the value of the sun's parallax obtained by other methods. Unfortunately it so happened that many of the observers in 1769 noted contacts of both kinds, and instead of finding the difference to be seventeen seconds, or thereabouts, they observed the differences varying from twenty to forty seconds, and in one or two instances attaining a yet greater value. This of itself would have sufficed to deprive the explanation of all real value; but it was further noted, by Continental and American astronomers, that the whole process by which explanation was attempted corresponded to what school boys call "fudging," or working backwards from the answer to the data of the question, with "allowances for error," whenever any discrepancy seemed disposed to make an appearance.* Nevertheless it was not doubted that the "black-drop" is a real cause of difficulty and error in observing contacts, and very elaborate preparations were made to overcome this difficulty. Models of the transit were constructed, both in Europe and America, on different plans—one devised by a Continental astronomer, the other by the American astronomers in Washington. Elaborate theories were devised to account for the peculiarities and varieties of the observed phenomena, and it was judged, not without reason, that the "black-drop" would not cause the same degree of trouble during the transit of 1874, as it had occasioned in 1761 and 1769, or at least to the mathematicians who had to deal with the results then obtained.

But when the transit was actually observed, it was found that the "black drop" was a much less serious cause of trouble than another, which, though recorded by observers in 1769, had somehow received much less notice than it deserved. Professor Grant, in his fine work, "The History of Physicial Astronomy," thus describes what was known of the phenomenon in question before the recent transit:

"It was remarked, by several observers of the transits of 1761 and 1769, that both at the ingress and egress, the portion of the limb of the planet that was off the sun was visible by means of a faint light surrounding it in the form of a ring. La Chappe, who observed the transit of 1761, at Tobolsk, in Siberia, states that the light of the ring was of a very deep yellow near the body of the planet, but that it became more brilliant towards the outer border. MM. Stromer, Mallett, Bergman, and Melander, who observed the same transit at Upsal, remarked that when three-fourths of the planet's limb had entered upon the sun, the remaining fourth was visible by means of a faint ring which appeared around it. A similar phenomenon was observed on the same occasion by Wargentin, at Stockholm, by Planmann, at Cajenburg, and in several other instances. Dr. Maskelyne, who observed the ingress of Venus upon the sun's disc at Greenwich, on the occassion of the transit of 1769, states that, when the planet was little more than half entered upon the sun, he said her whole

* For instance, the difference of seventeen seconds just mentioned was inferred from the result required, not from the facts given.

circumference was completed by means of a vivid, but narrow and ill-defined, border of light, which illuminated that part of her circumference which was off the sun. He adds, that it disappeared two or three minutes before the internal contact. A similar phenomenon was witnessed during the same transit by Wales and Dymond, at Hudson's Bay, by Pingré and De Fleurien, at Cape Francis, in the Island of St. Domingo, and by various other observers at different places.

A little consideration will suggest the true cause of this appearance, and show that its effect on the observation of internal contact can not but seriously affect the accuracy of the timing. No light can show itself round the portion of Venus outside the sun, between the moments of exterior and interior contact, unless the planet has an atmosphere capable of refracting the solar rays; but, if the planet has such an atmosphere, the observed effect can not but be produced. If we suppose an observer on Venus at a point P, on the part of her limb most remote from the sun—P not being the point which is seen from the earth at that part of the limb, but so placed that the true horizon-plane for an inhabitant of Venus there is parallel to the line from the observer on earth to the center of Venus—then, if there were no atmosphere, an observer at P could see neither the sun nor the earth, at least, not where the terrestrial observer is placed. The sun would be just below the true horizon of the observer on Venus, and so would the observer on earth; and *à fortiori* the observer on earth would not be able to see the sun round the part P of Venus. This part would be, as it were, the summit of a hill, from which the sun on one side and the earth on the other would be invisible, and therefore invisible from each other. But, if there is an atmosphere on Venus resembling our own atmosphere in its effects, the observer at P would see the sun raised by refraction above his horizon, and the earth, directly opposite, raised considerably above the horizon—precisely as at the time of total lunar eclipse—the observer on earth, if so placed that the eclipsed moon is apparently just above the horizon (really raised by refraction), can see the sun also directly opposite the moon, and raised wholly above the horizon. And as the line of sight from the observer at P to the sun on one side, and to the earth on the other, is thus twice bent by refraction, so the line of sight from the observer on earth to P is curved doubly as it passes P, and the sun is brought into that observer's range of view. The same is true for all points round that part of Venus' limb outside the sun, the atmosphere of Venus bringing greater and greater quantities of sunlight round the dark limb the nearer the part of the limb is to the sun. Thus, there is seen round the arc of Venus, outside the sun, a ring which is not to be regarded as mere sunlight, but as a distorted image of the sun himself.*

The effect of this phenomenon in modifying the conditions under which internal contact is observed, will be recognised at once. Observers were told to look for the moment when a line of sunlight suddenly made its way between the disc of Venus and the solar limb at ingress, or when the gradually narrowing line of sunlight was suddenly broken at egress. But here was true sunlight bounding the disc of Venus long before true contact took place at ingress, and long afterward at egress, so that the time to be noted was not that suddenly marked by the formation or breaking of a line of sunlight, but that when the sunlight, bounding the part of Venus outside the solar disc, was seen at ingress to become merged in the true outline of the sun, or at egress just began to disturb that outline. The observation to be made was of precisely the same order as an observation of external contact, and it had long been admitted that external contact can not be timed with sufficient accuracy to supply evidence for determining the solar parallax.

The very first news which reached us on the morning of December 9, pointed to this difficulty, or rather to this circumstance, practically rendering contact observations untrustworthy. We heard from the head of the English party in Egypt, that, after internal contact had, in reality, been established at egress, an arc of sunlight still remained visible around the part of Venus which was outside the sun; and that the observer, through waiting for this arc to break, lost the best cusp-measurements. Captain Tupman gives the following account of the phenomenon as observed at the stations where the transit began earliest of all, viz.: the set of stations on the Sandwich Isles: "The important phase of the phenomenon of internal contact presented wholly unexpected appearances, totally unlike what we had been led to anticipate. For many minutes before contact a faint light was seen behind Venus, beyond the sun's limb, rendering the complete circle of her disc visible. From that time, until the establishment of complete contact, no sudden or definite phase could be seized upon, such as the practice with the working model induced us to watch for. The eye observations of contact, therefore, do not present results of extreme value." Lieutenant Noble, at the same station, describes the phenomenon as follows: "From about ten minutes of the time

* This not only happens when Venus is placed as described, but when her disc is off the sun's. Professor Norton, has seen the whole circuit of Venus surrounded by a border of light at the time of inferior conjunction (within transit). In such case, the semi-circular arc of light nearest the sun, consists, in the main, of reflected sunlight, and the remaining are, in the main, of refracted sunlight.

of internal contact, I kept the telescope pointed at the sun's limb. While thus watching, I was astonished to see, most distinctly, the disc of the planet complete, and immediately asked Lieutenant Shakespear what time remained before contact; he said a little over five minutes." Mr. Nichol, at Honolulu, writes: "To my astonishment, I saw a completion of light round the planet perfectly distinct, and such as I should have said, from previous model contact, was immediately after contact. I got this time recorded as the first observation of contact, by seeing the continuous narrow band of light. I remained looking at it about two minutes, but could not see no instantaneous phenomenon of contact nor black-drop." We supposed the peculiarity due to light from the solar corona; but, under the conditions of observation, that explanation is quite untenable. We can not wonder to find Captain Tupman mentioning that Mr. Nichol recorded a time forty-seven seconds earlier than he did himself. Captain Tupman further says, that "there was nothing sudden to note" (as had been expected), "and the complete submergence was so gradual, any one might have recorded ten seconds before I did, and have been probably quite as accurate. My first impression was [that] such an observation could not possess any value. It was something similiar, in principle, to having to decide where the zodiacal light terminates! bearing in mind, of course, that we expected to get the contact within a second or so of time."

We can understand, then, the justice of the remark in the recently issued "Report to the Board of Visitors of the Greenwich Observatory," that while "there has been little annoyance from the dreaded 'black-drop'" (Mr. Stone's bugbear), "greater inconvenicnce and doubt have been caused by the unexpected luminous ring round Venus;" though why the phenomenon should have been unexpected, when Maskelyne, himself an astronomer-royal, recorded it so distinctly in 1769, is left unexplained. A very small amount of labor given to the examination of the records of former transits would have prevented this well known phenemenon from taking the observers by surprise; or, perhaps better, would have suggested that contact observations were little likely to be of use.

It may be well to supplement the above account by quoting the description of the same phenomenon as seen at St. Paul's Island, one of the "inaccessible if not absolutely mythical islands" of our Admiralty authorities, which the French (not usually regarded as more essentially nautical than we are) succeeded in occupying.* Immedi-

* At another of these myths (Campbell Island) the French observers had bad weather unfortunately, during the transit. But the Germans, at a third myth, (Auckland Island), saw the whole transit.

ately after the first identation at the sun's limb had been observed, M. Mouchez began to measure the distance between the cusps. "About a quarter of an hour," he proceeds, "after the first contract, when half the planet was still outside the sun, I perceived suddenly the entire disc of Venus, defined by a pale halo, brighter near the sun than at the summit of the planet" (that is, at the part remotest from the sun's edge). "To make sure that I was not under an illusion as regards this unexpected phenomenon I immediately reversed the position-circle of the micrometer to 180°, and measured that diameter of Venus which was still partly outside the sun, and I found it identical with the diameter perpendicular to the lines joining the centres; it was, therefore, really the entire well-defined disc of the planet which I saw. But in proportion as the second contact approached, the two extreme portions of the halo nearest the sun (and more distinctly seen) tended to unite, surrounding the segment still exterior to the sun with a brighter light, and this *too early* union (*réunion* anticipée) of the cusps by a luminous arc was rendered still more perfect by a narrow border of very bright light bounding the aureole on the disc of Venus. Foreseeing at once that there would be great difficulty in observing the geometrical contact, even if it would not be absolutely impossible, I quickly changed the darkening glass of pale blue for one of deeper tint, by means of which I hoped to extinguish this halo with its accidental gleams (*lueurs accidentelles*), but it was useless; the halo still remaining visible, I was obliged to take the original darkening glass again. Under such circumstances, I had to take the moment of contact, not the meeting of the two cusps, or the geometrical contact, but the moment when the sun's disc no longer seemed disturbed by the bright light which enveloped the planet at the point of contact. I observed a very sensible time-difference between the moments when I believed the contact might have been established and the moment when I felt *absolutely certain* that contact was established. . . . . The third contact was also observed under excellent conditions, in a very clear sky between clouds, with the same phenomena as at the second contact, but in reverse order."

It needs no elaborate argument to show that this peculiarity must altogether prevent the observation of contacts with the degree of accuracy necessary to *improve* our estimate of the sun's distance. With the improvement of telescopes the phenomenon will only be so much the more clearly recognized; and it must be quite impossible to experiment on this phenomenon as on the "black-drop," seeing that we can not represent by a model the action of an atmosphere whose real extent and refractive power are unknown to us.

Nor can photography be of any use in this matter; for the more perfect the photographic arrangements, the more exactly will the optical difficulty be reproduced. Indeed, in the photographic records of contact, during the recent transit, a peculiarity appears, which seems, of itself to introduce an absolutely insuperable difficulty. It would seem that the sun, which photographs itself, is slightly *larger* than the sun we see; in other words, that the gaseous matter of the sun emits light waves, producing that form of chemical action on which photography depends, from layers extending to a greater height than those which emit light waves recognizable by the eye in full sunlight. Janssen, at least, adopts this interpretation of the fact, that an ingress, as observed at Nagasaki, the planet appeared still attached to the solar limb, while the photographs taken, second by second, showed Venus already somewhat advanced on the sun's disc. It matters in truth, very little whether this explanation is correct or not, seeing that the observed facts, however explained, indicate a discrepancy between the optical and the photographic records of contact which must prevent our placing reliance on either. If we abandon contact observations, but one resource seems to be left. It is manifest that all methods have for their real object the determination of the chord of transit followed by Venus, as seen from different stations. When reliance was placed on Halley's method, for instance, although the element observed was the duration of transit, the element deduced was the length—and with the length the position—of the chord of transit. When reliance was placed on Delisle's method, the element observed was the epoch either of ingress or egress; but the element deduced was the *position* of the ingress or egress end of the chord of transit, and therefore of that chord itself.

The great difficulty in all other methods of determining the position of the chord of transit resides in the fact that the exact position of Venus on the sun's disc (not merely her distance from the center, but her bearing from the center, referred to some fixed line on the sun's disc,) must be determined for a precisely-timed moment. So that a double difficulty is introduced; first, the observations necessary to determine Venus's position require time, secondly, the exact longitude of the station should be known with as great accuracy as for Delisle's method. But the central part of the chord of transit—the part, namely, where the planet makes its nearest approach to the sun's centre—has this advantage over the other parts: the planet's distance changes so slowly as it is passing this portion, that an error of a few seconds would be comparatively of small importance. Moreover, this part of the chord is the most important because the distance of the chord from the sun's centre is what is really required. Now, setting aside the heliometic method, by which it was hoped that the distance of Venus from the sun's centre might be accurately determined, photography promised a means of indicating the required element very satisfactorily, because a solar photograph is secured in the fraction of a second, and ample means exist for indicating the precise instant at which each photograph is taken.

In a paper, the geometrical principles indicated in which were professedly adopted by Government astronomers in the choice of stations for photographing the late transit, I showed how the difficulty of indicating the exact angle of position of the line joining the centre of the disc might be obviated, and every thing made to depend on the measurement of the distance between the centres, assuming the longitude of the station known, and the exact instant of each photographic record assigned. It did not seem to me necessary to point out, that, as the time of mid-transit drew near, the effect of any time-error (whether in the indication of the instant of exposure, or in the determination of the longitude of the station) would be diminished; for this is a fact, not only obvious in itself, but taken for granted in the discussion of the whole matter by all who have considered the geometrical relations involved. So that I took it as self-evident that mid-transit was the time when photographic records for determining the chord of transit would have greatest value. And it was easy to perceive that, in some cases it might be advantageous to select stations, either solely or chiefly with reference to the important phase of mid-transit; in other words, to select stations where neither the beginning nor the end of transit could be photographed under favorable conditions, but where the middle of transit would be most advantageously observable. However, when this obvious particular case of general theory I had dealt with was pointed out by Mr. E. L. Garbett, I presented the suggestion as though it contained somewhat of novelty, not caring at that time to show how completely it was included in the general reasoning advanced by Colonel Tennant, Dr. De la Rue, and, more fully by myself.*

On the occasion of the late transit only one station was specially suited for mid-transit photography—Cape Town. Though Natal would have been worth occupying, Cape Town was superior to every other southern station for this particular purpose. But somehow the suggestion that photographs should be secured there was overlooked,

* Nor should I now call attention to the point but that the special form of thanks adopted by Mr. Garbett for what, in reality was unnecessary generosity, consisted in denunciations addressed to me for overlooking the point which had appeared to myself and others too obvious for special mention.

and a new cause of regret added to several which will be recognized by those who come after us, as they scan the history of the late transit.

But in 1882 this method—the mid-transit photographic method—will be the one on which, I venture to predict, chief reliance will be placed. Owing to the long duration of that transit (exceeding, by two hours, the duration of the recent transit,) it will be impossible to find any pairs of stations, northern and southern, at each of which the whole transit will be favorable seen. * * * So far, then, as the older methods of observing transits are concerned, the transit of 1882 can only be observed by Delisle's method. But we have seen that contact observations can not be relied upon for improving our knowledge of the sun's distance. And if they could not be relied upon for that purpose now, astronomers will have secured valuable determinations of the sun's distance from observations of the planet Mars, during the singularly favorable opposition of 1877.*

But mid-transit can be advantageously recorded by photographic appliances in 1882, if only suitable southern stations can be occupied for the purpose ; and as no other method is available, except the demonstrably untrustworthy Delislean method, we can scarcely doubt that an effort will be made by the scientific nations to overcome the difficulties which will be certainly present themselves in the search for and occupation of stations in the southern hemisphere. * *

And there will be this further difficulty in 1882. On the occasion of the late transit the Americans, finding that no part of the transit would be visible from their own territory, appear to have considered it their natural and obvious duty to occupy stations in Siberia, Japan, the Sub-Antarctic ocean, and other places, where we in England were assured that no stations *would* be, and that no stations *could* be occupied. But in 1882 the whole transit being most favourably observable from the whole part of the United States, it seems not unlikely that our Transatlantic cousins will consider it their part to keep their astronomers at home, leaving to other nations the task of finding suitable southern stations. I hesitate to say that this *will* be their view of the matter, for it is difficult to reckon on considerations of that kind where Americans are concerned. One might have thought, that after observing the eclipse of 1869 at a hundred stations in the United States, American astronomers would have been content to leave the observations of the Mediterranean eclipse of 1870 to European astronomers. But, in point of fact, they did nothing of the kind ; but, with a perversity which can not be too strongly reprehended (at least

* It may well be hoped that stellar photography, will be employed to obtain records of the position of Mars among the stars on that occasion. This method seems to promise better results than any other yet applied, or at present available.

by all who admire our *laisser aller* system), they insisted not only on sending over astronomers, but on positively inviting English astronomers (finding we had made no arrangements for observing the eclipse) to sail with their expedition to inaccessible Mediterranean regions. However, supposing that in 1882 the attractions of the transit, as observable at home, should prevent the Americans from visiting the southern hemisphere in great strength, the duty will fall on European nations. Germany and France may then, as last December, occupy three or four southern myths. But three or four will not be enough. England will be almost bound to share in the work.

Then arises the question, where is England to send her observers in those southern seas? Unless new islands can be discovered there, no positions worthy of her ancient fame will remain for her to occupy, save precisely those Antarctic islands which were described, in 1868, by one naval authority after another, as accessible, tenable and suitable, but, unfortunately, by the same authorities, in 1873, as inaccessible, untenable and unsuitable. Assuming, as we may not unreasonably do, that the latter description meant only that it would cost more time, trouble and money to occupy these regions, than any conceivable astronomical result could repay, we are brought back to the considerations which were urged by the Astronomer Royal, as long ago as 1865, in order to bring schemes of Antarctic explorations favorably before the notice of geographers and naval authorities. With these considerations I shall conclude, merely remarking that whatever force his views had when presented, they have greatly increased force, now that an Arctic expedition is in progress, the value of the results obtained by which, would be far more than doubled by a successful Antarctic expedition following close upon the successful issue of that which has lately set forth. "I have learned," he wrote to the President of the Geographical Society, "through the public papers, the tenor of late discussions at the Royal Geographical Society, in reference to the proposal for an expedition towards the North Pole. I gather from these, that the object proposed, as bearing on science, is not so much specific as general; that there is no single point of very great importance to be obtained, but a number of co-ordinate objects whose aggregate would be valuable. And, I conclude, that the field is still open for a proposal which would give opportunity for the determination of various results, corresponding in kind and importance to those of the proposed Northern Expedition, though in a different locality, and would also give information on a point of great importance to astronomy, which must be sought within a few years, and which it is desirable to obtain as early as possible. In the year 1882, on December 6, a transit of Venus over the sun's disc will occur—the most favorable of all phenomena for solution of the noble problem of determining the suns's distance from the earth, provided that proper stations for the observations can be found. (It will be remembered that it was for the same purpose that the most celebrated of all the British scientific expeditions, namely, that of Captain Cook to Otaheite, in 1769, was undertaken.) For the northern stations there will be no difficulty; they will be on the Atlantic seaboard of North America, or at Bermuda; all very favorable and very accessible. For the southern stations the selection is not so easy; the observation must be made on the Antarctic Continent, if proper localities can be found there, and if the circumstances of weather, etc., are favorable, the determination will be excellent; if these circumstances do not hold, no use, whatever, can be made of the transit. The astronomical object of a southern expedition is, I trust, sufficiently explained. In the event of such an expedition being undertaken, the precise determinations which I have indicated as bearing on the astronomical question, must (from the nature of the case) take precedence of all others. But there would be no difficulty in combining with them any other inquiries, of geography, geology, hydrography, magnetism, meteorology, natural history, or any other subject for which the localities are suitable. And I have now to request that you will have the kindness to communicate these remarks to the Royal Geographical Society, and to take the sense of the Society on the question, whether it is not desirable, if other scientific bodies should co-operate, that a representation be made by the Royal Geographical Society to Her Majesty's Government on the advantage of making such a reconnaissance of the Southern Continent, as I have proposed; primarily in the interest of astronomy (referring to my official responsibility for the importance of the examination at this special time); but conjointly with that, in the interests, perhaps ultimately more important, of geography and other sciences usually promoted by the Royal Geographical Society."—*Popular Science Review, Eng.*

Zoological Recreation in Florida Bay. By W. W. Calkins.

> "How silent are the winds! no billow roars,
> But all is tranquil as Elysian shores."

We lay off Sandy Key, I awoke with the first gray dawn of morning, and going on deck to get a little sniff of fresh air, was agreeably surprised to find that the fierce storm of the night had given place to a perfect calm. The "Mud Banks," covering several hundred acres, were entirely bare of water. Here was our opportunity. I proclaimed the discovery to my comrades below by a sort of Indian whoop, that brought the Colonel to the deck instanter, minus a shirt button, who upon ascertaining the cause of the explosion and bestowing a few adjectives of admiration, retired for repairs. The frugal meal of bacon, hard tack, and coffee, being over, we prepared to disembark. This did not take long. The most we required being some baskets and a canteen of rainwater. The latter being very necessary, as the weather was hot and thirst easily excited. Since leaving the mouth of the Mississippi we had been engaged in washing out the fluviatile deposits of that delectable stream, which seemed disposed to form jetties all through our systems. Rainwater *straight*, less a few pollywogs, was our main stay. But even this, after having circulated, percolated, and exuded, through our epidermis, seemed to change its nature into that of the marine element around us. Ice was *non est*. Key West lightning was seventy miles away. And so reduced to the pure *aqua* we resolved to make the best of it. Having embarked in the dingy we were soon on *terra firma* again. Landing on the Key we explored the beach as far as the point where the mud banks began. The tide being out, was most favorable for our purpose. The wind and waves had done us good service in washing up shells, which the day before we had not seen. Most of these were shallow water species. *Cerith. muscarum*, (Say), and *Bulla occidentalis*, (Ad.), were abundant. The mangrove trees growing out in the water were fully exposed to view. About their network of roots were many thousands of *Ostreas*, or raccoon oysters. Some were finely colored and of large size. Having tested their edible qualities we collected some of the finest specimens. Clinging to the shells were *Mytilus hamatus*, (Say), and a *Perna*. The "Mud Banks" which extended out into the Bay. from the upper end of the Key, next engaged our attention. Several hundred acres were bare of water, thus affording a fine opportunity for securing species not easily obtained at other times. One of the first, the largest and most abundant, that we saw, was *Fasc. gigantea*, (Kiener). The shell sometimes attains a length of two feet, without, of a brownish red color, within, the aperture is of a carmine reddish hue, the same as the foot of the animal. An operculum attached to this forms a door, and enables the occupant to shut itself in most effectually. The spawn cases, containing the young shells, are immense, some being three feet long, and each case about the size of a half dollar, and twice as thick, is united to the next by a long ribbon, which connects the whole series together. This is simply deposited by the female in the mud. The thousands of young mollusks are then left to shift for themselves. Having broken their prison walls, they grow rapidly and are scattered over the sea. Of the millions born, probably more than two-thirds fall a prey to their enemies while young. We found them in every stage of growth. There would have been no difficulty in securing a wagon load of full grown shells right here, so the supply is not likely to give ont. The smaller species—*Fasc. tulipa*, (L.), and *Fasc. distans*, (Lam.)—were quite abundant. The shells were clean, smooth, and highly colored. In the same locality occurred fine specimens of *Sycotypus canaliculatus*, (L.), *S. pyrum*, (Dill.), *S. carica*, (Gmel.), *S. perversus*, (L.), *S. papyraceus*, (Say), *Arca Noæ*, (L.), I found attached to other shells, while *Arca ponderosa*, (Say), an inhabitant of deeper water, was found on the mud banks, and had evidently been washed up by the storm along with some other species. In the valves of dead shells were *Crepidula plana*, (Say), and *C. fornicata*, (Lam.), *Venus cingenda*, (Dill.), were abundant, *Callista gigantea*, (Chem.), and *C. maculata*, (L.), *Ranella caudata*, (Say), *Plicatula ramosa*, (Lam.), *Murex tampænsis*, (Con.), *Fissurellas* and *Pectunculus*, afforded us good specimens. Some of each species I put in the alcohol jars for future study of the animals. No naturalist should go to Florida unprovided with plenty of alcohol, nor fail to preserve the animals of every species collected. Careful notes of localities and surroundings should also be made. In addition to the species mentioned above we found some that were common to other parts of Florida, and which I mentioned in former papers. One, however, of which I had previously seen only the dead shells, occurred on the banks around Sandy Key in great perfection and abundance. This was *Pinna muricata*, (L.), or the fan mussel. Standing on their small ends, about one-third buried in the mud with valves open, they resemble a collection of fans. A hairy caudal appendage, called *a byssus*, and fine in texture as silk, is attached to the animal. By means of this they attach themselves to whatever debris may be near them in the mud where they locate, and having assumed an upright position, are ready with open mouths to snap up whatever unfortunate mollusk ventures within reach. At the slightest touch they close the valves quickly, and by a sucking process hang on with their byssus most tenaciously to the attachment below. The longest were about ten inches to a foot long. I soon learned to take them suddenly, and in this way secured enough to fill a barrel in a short time. Like the oysters they have their parasite (*Pinnotheres.*) These little crabs nestle in the mantle and gills of the animal. On the exterior of the shell, *Anomia glabra*, (Ver.), and *Crepidulas*, make their home.

While we were doing our best to secure all the species we could and explore as much ground as possible, we kept one eye seaward as symptoms of the returning tide began to appear. But when we were finally driven off it was with full loads, and we considered the results satisfactory. Having transferred our spoils to the schooner, we bade farewell to Sandy Key, and at two o'clock in the afternoon sailed for Cape Sable. By the calculation of the Captain the distance was seven miles. The wind having freshened up we sailed over in a little more than an hour, and came to anchor off the Cape. A number of sharks were taking their daily rations of mullets and other small fish along the shore. On one side of us was the sea, on the other a wilderness of vast extent and uninhabited. Just the place for fun, as the Doctor remarked, while we were going ashore, but the Captain who had left his lassie at Key West could not see the point. Along the shore the land is much higher than it is further back, and a narrow strip had evidently been cleared and cultivated at some former time. It seems that during the Seminole war a force was stationed here. On examination we found the remains of a cellar, and a few timbers. The clearing was now overgrown with coarse grass, thistles, and a species of *Cactus*. We saw numerous large holes excavated here and there. These belong to the gopher turtle. Having examined the ground carefully, we found under the leaves of the thistles several species of land shells, *Helix nonlifera*, (Shutt.), *Helix carpenteriana*, (Bland), and a small variety of *Glandina*, were quite abundant. A recent fire, of which we saw the marks, had destroyed some other species no doubt. We next began our investigations in the adjoining forest. Along its margin were growing palms, papagas and gums. On the latter were obtained numerous specimens of *Orthalicus Zebra*, (Brug.), similar to those at Sandy Key. We first saw here *Lignus fasciata*, (Mul.) There were two varieties distinguished by the presence of black and yellow bands. The tidal wave and hurricane that occurred in Florida a few years ago had done much damage to the trees, as many of them were overturned, and the signs of devastation everywhere apparent. Having "beat around the bush" long enough to satisfy our curiosity, we resolved to explore further within the wilderness. This was no easy matter. A tangled mass of young mangroves, *Cactaceæ*, (such as the night blooming cereus), and other tropical vegetation, filled up the spaces between the larger trees, and rendered our progress one of difficulty. All the mosquitoes in Florida seemed to have concentrated for the purpose of giving us a bloody welcome. I should say they were of the same genera as the Northern variety, but much fiercer, and not having tasted the blood of a Yankee for some time, determined to make the most of the present opportunity. After getting fairly into the swamp, the Doctor suddenly paused under a mangrove, and called my attention to the top of the tree. On the branches were most beautiful flowers in full bloom. These are known as *Orchids*, or air plants. There were two species. They simply cling to the bark with their tough fibrous roots, and present a very novel appearance. They were not confined to mangroves, but occur on other trees. On further examination we found many hundreds. This sight was alone worth all our trouble. The Doctor proceeded to climb a mangrove, and had gone up some ten feet, when I warned him to look out for hornets, as I saw one fly out of the foliage of a plant. This being followed by several more, made him exclaim that he believed there were hornets around. A fact that I was ready to affirm, when down came my friend in a manner more rapid and emphatic than graceful. Having beat a retreat to a safer position we secured as many specimens as we wanted, and pursued our way through the swamp. At last I climbed a tree, and seeing no end to the same unvarying prospect, we worked our way back to the coast, and went on board the vessel.

Of the air-plants, which I brought safely home, one proves to be *Epidendrum conopseum*, (Ait.) The other has not been determined.

On Animal Instinct: in its Relation to the Mind of Man. BY THE DUKE OF ARGYLL.

The very old question whether animals are "automata" was raised by Professor Huxley in the *Fortnightly Review* for November, 1874. It has been since pursued here in successive papers of much ability by Dr. Carpenter and Mr. Mivart. I find myself in partial agreement sometimes with one, sometimes with another of these writers, and yet on some important matters dissenting from them all. Approaching the subject from a different point of view, I cannot better explain the aspect in which this question presents itself to me than by discussing it in connection with certain exhibitions of animal instinct which I had occasion to observe during the spring and summer of last year. They were not uncommon cases. On the contrary they were of a kind of which the whole world is full. But not the less directly did they suggest all the problems under discussion, and not the less forcibly did they strike me with the admiration and the wonder which no familiarity can exhaust.

The Dipper or Water-ousel (*Cinclus aquaticus*) is well known to ornithologists as one of the most curious and interesting of British birds. Its special habitat is clear mountain streams. These it never leaves except to visit the lakes into which or from which they flow. Without the assistance of webbed feet it has extraordinary powers of swimming and of diving—moving about, upon, and under the surface with more than the ease and dexterity of a fish—hunting along the bottom as if it had no power to float—floating on the top as if it had no power to sink—now diving where the stream is smooth, now where it is quick and broken, and suddenly reappearing perched on the summit of some projecting point. Its plumage is in perfect harmony with its "environment"—dark, with a pure white breast, which looks exactly like one of the flashes of light so numerous in rapid streams, or one of the little balls of foam which loiter among the stones. Its very song is set to the music of rapid waters. No bird, perhaps, is more especially adapted to a very special home, and very peculiar habits of life. The same species, or other forms so closely similar as to seem mere varieties, are found in almost every country of the world where there are mountain streams. And yet it is a species having no very near affinity with any other bird, and it constitutes by itself a separate genus. It is therefore a species of great interest to the naturalist, and raises some of the most perplexing questions connected with the "origin of species."

A pair of these birds built their nest last year at Inverary, in a hole in the wall of a small tunnel constructed to carry a rivulet under the walks of a pleasure ground. The season was one of great drought, and the rivulet, during the whole time of incubation, and of the growth of the young in the nest, was nearly entirely dry. One of the nestlings when almost fully fledged, was taken out by the hand for examination, an operation which so alarmed the others that they darted out of the hole, and ran and fluttered down the tunnel towards its mouth. At that point a considerable pool of water had survived the drought, and lay in the path of the fugitives. They did not at all appear to seek it; on the contrary, their flight seemed to be as aimless as that of any other fledgling would have been in the same predicament. But one of them stumbled into the pool. The effect was most curious. When the young bird touched the water there was a moment of pause, as if the creature was surprised. Then instantly there seemed to wake within it the sense of its hereditary powers. Down it dived with all the facility of its parents, and the action of its wings under the water was a beautiful exhibition of the double adaptation to progression in two very different elements, which is peculiar to the wings of most of the diving birds. The young Dipper was immediately lost to sight among some weeds, and so long did it remain under water that I feared it must be drowned. But in due time it reappeared all right, and, being recaptured, was replaced in the nest.

Later in the season on a secluded lake in one of the Hebrides, I observed a Dundiver, or female of the Red-breasted Mergauser (*Mergus Serrator*) with her brood of young ducklings. On giving chase in the boat, we soon found that the young, although not above a fortnight old, had such extraordinary powers of swimming and diving that it was almost impossible to capture them. The distance they went under water, and the unexpected places in which they emerged baffled all our efforts for a considerable time. At last one of the brood made for the shore, with the object of hiding among the grass and heather which fringed the margin of the lake. We pursued it as closely as we could, but when the little bird gained the shore, our boat was still about twenty yards off. Long drought had left a broad margin of small flat stones and mud between the water and the usual bank. I saw the little bird run up about a couple of yards from the water, and then suddenly disappear. Knowing what was likely to be enacted, I kept my eye fixed on the spot; and when the boat was run upon the beach, I proceeded to find and pick up the chick. But on reaching the place of disappearance, no sign of the young Mergauser was to be seen. The closest scrutiny, with the certain knowledge that it was there, failed to enable me to detect it. Proceeding cautiously forwards, I soon became convinced that I had already overshot the mark; and, on turning round it was only to see the bird rise like an apparition from the stones, and dashing past the stranded boat, regain the lake,—where, having now recovered its wind, it instantly dived and disappeared. The tactical skill of the whole of this manœuvre, and the success with which it was executed, were greeted with loud cheers from the whole party; and our admiration was not diminished when we remembered that some two weeks before that time the little performer had been coiled up inside the shell of an egg, and that about a month before it was nothing but a mass of albumen and of fatty oils.

The third case of animal instinct which I shall here mention was of a different but of an equally common kind. In walking along the side of a river with overhanging banks, I came suddenly on a common Wild Duck (*Anas Boschus*) whose young were just out. Springing from under the bank, she fluttered out into the stream with loud cries and with all the struggles to escape of a helplessly wounded bird. To simulate the effects of suffering from disease, or from strong emotion, or from wounds upon the human frame, is a common necessity of the actor's art, and it is not often really well done. The tricks of the theatre are seldom natural, and it is not without reason that "theatrical" has become a proverbial expression for false and artificial representations of the realities of life. It was therefore with no small interest that on this, as on many other occasions, I watched the perfection of an art which Mrs. Siddons might have envied. The labored and half convulsive flapping of the wings, the wriggling of the body, the straining of the neck, and the whole expression of painful and abortive effort, were really admirable. When her struggles had carried her a considerable distance, and she saw that they produced no effect in tempting us to follow, she made resounding flaps upon the surface of the water, to secure that attention to herself which it was the great object of the manœuvre to attract. Then, rising suddenly in the air, she made a great circle round us, and returning to the spot renewed her endeavors as before. It was not, however, necessary: for the separate instinct of the young in successful hiding effectually baffled all my attempts to discover them.

Let us now look at the questions which these several exhibitions of animal instinct cannot fail to suggest; and first let us take the case of the young Dipper. There was no possibility of imitation here. The rivulet beneath the nest, even if it had been visible to the nestlings, had been dry ever since they had been hatched. The river into which it ordinarily flowed was out of sight. The young Dippers never could have seen the parent birds either swimming or diving. This, therefore, is one of the thousand cases which have driven the "experience" school of philosophy to take up new ground. The young Dipper here cannot possibly have had any experience, either through the process of incipient effort, or through the process of sight and imitation. Nature is full of similar cases. In face of them it is now no longer denied that in all such cases "innate ideas" do exist, and that "pre-established harmonies" do prevail in nature. These old doctrines, so long ridiculed and denied, have come to be admitted, and the new philosophy is satisfied with attempts to explain how these "ideas" came to be innate, and how these harmonies came to be pre-established. The explanation is, that, though the efficiency of experience as the cause or source of instinct must be given up as regards the individual, we may keep it as regards the race to which the individual belongs. The powers of swimming and diving, and the impulse to use them for their appropriate purpose, were indeed innate in the little Dipper of 1874. But then they were not innate in its remote progenitors. They were acquired by those progenitors through gradual effort—the trying leading to success, and the success again leading to more trying—both together leading first to special faculty, then to confirmed habit, and then, by hereditary transmission, to instinct "organized in the race." Well, but even if this be true, was not the disposition of the progenitors to make the first efforts in the direction of swimming and diving, and were not the organs which enabled them to do so, as purely innate as the perfected instinct and the perfected organs of the Dipper of to-day? Did there ever exist in any former period of the world what, so far as I know, does certainly not exist now—any animal with dispositions to enter on a new career, thought of and imagined for the first time by itself, unconnected with any organs already fitted for and appropriate to the purpose? Even the highest acquirements of the Dog, under highly artificial conditions of existence, and under the guidance of persistent "interferences with nature," are nothing but the special education of original instincts. In the almost human caution of the old and well-trained pointer when approaching game, we see simply a development of the habit of all predatory animals to pause when close upon an unseen prey—a pause requisite to verify the intimations of smell by the sense of sight, and also for preparing the final spring. It is true that man "selects;" but he can only select out of what is already there. The training and direction which he gives to the promptings of instinct may properly be described as the result of experience in the animal under instruction; and it is undoubtedly true, that within certain limits (which, however, are after all very narrow) these results do tend to become hereditary. But there is nothing really analogous in nature to the artificial processes of training to which Man subjects the animals which are capable of domestication. Or if there be anything analogous—if animals by themselves can school themselves by gradual effort into the development of new powers—if the habits and powers which are now purely innate and instinctive, were once less innate and more deliberate—then it will follow that the earlier faculties of animals have been the higher, and the latter faculties are the lower in the scale of intelligence. This is hardly consistent with the idea of evolution,—which is founded on the conception of an unfolding or development from the lower to the higher, from the simple to the complex, from the instinctive to the rational. My own belief is, that whatever of truth there is in the doctrine of evolution is to be found in this conception, which so far as we can see, does seem to be embodied in the history of organic life. I can there therefore see no light in this new explanation to account for the existence of instincts which are centainly antecedent to all individual experience—the explanation, namely, that they are due to the experience of progenitors "organized in the race." It involves assumptions contrary to the analogies of nature, and at variance with the fundamental facts which are the best and, indeed, the only basis of the theory of evolution. There is no probability—there is hardly any plausibility—in the supposition that experience has had, in past times, some connection with instinct which it has ceased to have in the present day. The uniformity of nature has, indeed, often been asserted in a sense in which it is not true, and used in support of arguments which it will not sustain. All things have certainly not continued as they are since the begining. There was a time when animal life, and with it animal instincts, began to be. But we have no reason whatever to suppose that the nature of instinct then or since has ever been different from its nature now. On the contrary, as we have in existing nature examples of it in infinite variety, from the very lowest to the very highest forms of organization, and as the same phenomena are everywhere repeated, we have the best reason to conclude that, in the past, animal instinct has ever been what we now see it to be, congenital, innate, and wholly independent of experience.

And indeed, when we come to think about it, we shall find that the theory of experience assumes the pre-existence of the very powers for which it professes to account. The very lowest of the faculties by which experience is acquired is the faculty of imitation. But the desire to imitate must be as instinctive as the organs are hereditary by which imitation is effected. Then follow in their order all the higher faculties by which the lessons of experience are put together—so that what has been in the past is made the basis of anticipation as to what will be in the future. This is the essential process by which experience is acquired, and every step in that process assumes the pre-existence of mental tendencies and of mental powers which are purely instinctive and innate. To account for instinct by experience is nothing but an Irish bull. It denies the existence of things which are nevertheless assumed in the very terms of the denial: it elevates into a cause that which must in its nature be a consequence, and a consequence, too, of the very cause which is denied. Congenital instincts, and hereditary powers, and pre-established harmonies, are the origin of all experience, and without them no one step in experience could ever be gained. The questions raised when a young Dipper, which had never before even seen water, dives and swims with perfect ease, are questions which the theory of organized experience does not even tend to solve; on the contrary it is a theory which leaves those questions precisely where they were, except in so far as it may tend to obscure them by obvious confusions of thought.

Passing now from explanations which explain nothing, is there any light in the theory that animals are "automata?" Was my little Dipper a diving machine? It seems to me that there is at least a glimmer shining through this idea—a glimmer as of real light struggling through a thick fog. The fog arises out of the mists of language—the confounding and confusing of meanings literal with meanings metaphorical—the mistaking of partial for complete analogies. Machine is the word by which we designate those combinations of mechanical force which are contrived and put together by man to do certain things. One essential characteristic of them is that they belong to the world of the not-living; they are destitute of that which we know as life, and of all the attributes by which it is distinguished. Machines have no sensibility. When we say of anything that it has been done by a machine, we mean that it has been done by something which is not alive. In this literal signification it is therefore pure nonsense to say that anything living is a machine. It is simply a misapplication of language, to the extent of calling one thing by the name of another thing, and that other so different as to be its opposite or contradictory. There can be no reasoning, no clearing up of truth, unless we keep definite words for definite ideas. Or if the idea to which a given word has been appropriated be a complex idea, and we desire to deal with one element only of the meaning, separated from the rest, then, indeed, we may continue to use the word for this selected portion of its meaning, provided always that we bear in mind what it is that we are doing. This may be, and often is, a necessary operation, for language is not rich enough to furnish separate words for all the complex elements which enter into ideas apparently very simple; and so of this word, machine, there is an element in its meaning which is always very important, which in common language is often pre-dominant, and which we may legitimately choose to make exclusive of every other. This essential element in our idea of a machine, is that its powers, whatever they may be, are derived and not original. There may be great knowledge in the work done by a machine, but the knowledge is not in it. There may be great skill, but the skill is not in it; great foresight, but the foresight is not in it; in short, great exhibition of all the powers of mind, but the mind is not in the machine itself. Whatever it does is done in virtue of its construction, which construction is due to a mind which has designed it for the exhibition of certain powers, and the performance of certain functions. These may be very simple, or they may be very complicated, but whether simple or complicated, the whole play of its operations is limited and measured by the intentions of its constructor. If that constructor be himself limited, either in opportunity, or knowledge, or in power, there will be a corresponding limitation in the things which he invents and makes. Accordingly, in regard to man, he cannot make a machine which has any of the gifts and the powers of life. He can construct nothing which has sensibility or consciousness, or any other of even the lowest attributes of living creatures. And this absolute destitution of even apparent originality in a machine—this entire absence of any share of consciousness, or of sensibility, or of will—is one part of our very conception of it. But that other part of our conception of a machine, which consists in its relation to a contriver and constructor, is equally essential, and may, if we choose, be separated from the rest, and may be taken as representative of the whole. If, then, there be any Agency in Nature, or outside of it, which can contrive and build up structures endowed with the gifts of life, structures which shall not only digest, but which shall also feel and see, which shall be sensible of enjoyment from things conducive to their welfare, and of alarm on account of things which are dangerous to the same—then such structures have the same relation to that Agency which machines have to Man, and in this aspect it may be a legitimate figure of speech to call them living machines. What these machines do is different in kind from the things which human machines do; but both are alike in this—that whatever they do is done in virtue of their construction, and of the powers which have been given to them by the mind which made them.

Applying now this idea of a machine to the phenomena exhibited by the young Dipper, its complete applicability cannot be denied. In the first place the young Dipper had a physical structure adapted to diving. Its feathers were of a texture to throw off water, and the shower of pearly drops which ran off it, when it emerged from its first plunge, showed in a moment how different it was from other fledglings in its imperviousness to wet. Water appeared to be its "native element" precisely in the same sense in which it is said to be the native element of a ship which has been built high in air, and of the not very watery materials of wood and iron. Water which it had never seen before seemed to be the native element of the little bird in this sense, that it was so constructed as to be and to feel at home in it at once. Its "lines" had been laid down for progression both in air and water. It was launched with a motive power complete within itself, and with promptings sufficient for the driving of its own machinery. For the physical adaptation was obviously united with mental powers and qualities which partook of the same pre-adjusted harmony. These were as congenital as the texture of its feathers or the structure of its wing. Its terror arose on seeing the proper objects of fear, although they had never been seen before, and no experience of injury had arisen. This terror prompted it to the proper methods of escape, and the knowledge how to use its faculties for this object was as intuitive as the apparatus for effecting it was hereditary. In this sense the Dipper was a living, breathing, seeing, fearing, and diving machine—ready made for all these purposes from the nest—as some other birds are even from their first exclusion from the egg.

The case of the young Mergauser is still more curious and instructive with reference to the same questions. The young of all the *Anatidæ* are born, like the gallinaceous birds, not naked or blind as most others are, but completely equipped with a feathery down, and able to swim or dive as soon as they see the light. Moreover the young of the Mergauser have the benefit of seeing from the first the parent bird performing these operations, so that imitation may have some part in developing the perfection with which they are executed by the young. But the particular manœuvre resorted to by the young bird which baffled our pursuit, was a manœuvre in which it could have had no instruction from example—the manœuvre, namely, which consists in hiding not under any cover but by remaining perfectly motionless on the ground. This is a method of escape which cannot be resorted to successfully except by birds whose coloring is adapted to the purpose by a close assimilation with the coloring of surrounding objects. The old bird would not have been concealed on the same ground, and would never itself resort to the same method of escape. The young, therefore, cannot have been instructed in it by the method of example. But the small size of the chick, together with its obscure and curiously mottled coloring, are specially adapted to this mode of concealment. The young of all birds which breed upon the ground are provided with a garment in such perfect harmony with surrounding effects of light as to render this manœuvre easy. It depends, however, wholly for its success upon absolute stillness. The slightest motion at once attracts the eye of any enemy which is searching for the young. And this absolute stillness must be preserved amidst all the emotions of fear and terror which the close approach of the object of alarm must, and obviously does, inspire. Whence comes this splendid, even if it be unconscious faith, in the sufficiency of a defense which it must require such nerve and strength of will to practice? No movement, not even the slightest, though the enemy should seem about to trample on it; such is the terrible requirement of Nature—and by the child of Nature implicitly obeyed! Here again, beyond all question, we have an instinct as much born with the creature as the harmonious tinting of its plumage—the external furnishing being inseparably united with the internal furnishing of mind which enables the little creature in very truth to "walk by faith and not by sight." Is this automatonism? Is this machinery? Yes, undoubtedly, in the sense explained before—that the instinct has been given to the bird in precisely the same sense in which its structure has been given to it—so that anterior to all experience, and without the aid of instruction or of example, it is inspired to act in this manner on the appropriate occasion arising.

Then, in the case of the Wild Duck, we rise to a yet higher form of instinct, and to more complicated adaptations of congenital powers to the contingencies of the external world. It is not really conceivable that Wild Ducks have commonly many opportunities of studying each other's action when rendered helpless by wounds. Nor is it conceivable that such study can have been deliberately made even when opportunites do occur. When one out of a flock is wounded all the others make haste to escape, and it is certain that this trick of imitated helplessness is practised by individual birds which can never have had any such opportunities at all. Moreover there is one very remarkable circumstance connected with this instinct, which marks how much of knowledge and of reasoning is implicitly contained within it. As against Man the manœuvre is not only useless but it is injurious. When a man sees a bird resorting to this imitation, he is deceived for a moment, as I have myself been; but his knowledge and experience and his reasoning faculty soon tell him, from a combination of circumstances, that it is merely the usual deception. To Man, therefore, it has the opposite effect of revealing the proximity of the young brood, which would not otherwise be known. I have repeatedly been led by it to the discovery of the chicks. Now, the most curious fact of all is that this distinction between Man and other predacious animals is recognized and reflected in the instinct of birds. The manœuvre of counterfeiting helplessness is very rarely resorted to except when a dog is present. Dogs are almost uniformly deceived by it. They never can resist the temptation presented by a bird which flutters apparently helpless just in front of their nose. It is, therefore, almost always successful in drawing them off and so rescuing the young from danger. But it is the sense of smell, not the sense of sight which makes dogs so specially dangerous. The instinct which has been given to birds seems to cover and include the knowledge that as the sense of smell does not exist to the like effect in Man, the mere concealment of the young from sight is ordinarily as regards him sufficient for their protection; and yet I have on one occasion seen the trick resorted to when Man only was the source of danger, and this by a species of bird which does not habitually practise it, and which can neither have had individual nor ancestral experience. This was the case of a Blackcap (*Sylvia Atricapilla*) which fell to the ground as if wounded from a bush, in order to distract attention from its nest.

If now we examine, in the light of our own reason, all the elements of knowledge or of intellectual perception upon which the instinct of the Wild Duck is founded, and all of which, as existing somewhere, it undoubtedly reflects, we shall soon see how various and extensive these elements of knowledge are. First, there is the knowledge that the cause of the alarm is a carnivorous animal. On this fundamental point no creature is ever deceived. The youngest chick knows a hawk, and the dreadful form fills it with instant terror. Next there is knowledge that dogs and other carnivorous quadrupeds have the sense of smell, as an additional element of danger to the creatures on which they prey. Next, there is the knowledge that the dog, not being itself a flying animal, has sense enough not to attempt the pursuit of prey which can avail itself of this sure and easy method of escape. Next there is the conclusion from all this knowledge, that if the dog is to be induced to chase, it must be led to suppose that the power of flight has been somehow lost. And then there is the farther conclusion that this can only be done by such an accurate imitation of a disabled bird as shall deceive the enemy into a belief in the possibility of capture. And lastly there are all the powers of memory and the qualities of imagination which enable good acting to be performed. All this reasoning and all this knowledge is certainly involved in the action of the bird-mother, just as certainly as reasoning and knowledge of a much profounder kind is involved in the structure or adjustment of the organic machinery by which and through which the action is itself performed.

There is unquestionably a sense, and a very important sense, in which all these wonderful operations of instinct are "automatic." The intimate knowledge of physical and of physiological laws—the knowledge even of the mental qualities and dispositions of other animals—and the processes of reasoning by which advantage is taken of these,—this knowledge and this reasoning cannot, without manifest absurdity, be attributed to the birds themselves. This is admitted at least as regards the birds of the present day. But surely the absurdity is quite as great if this knowledge and reasoning, or any part of it, be attributed to the birds of a former generation. In the past history of the species there may have been change—there may have been development. But there is not the smallest reason to believe that the progenitors of any bird or of any beast, however different in form, have ever founded on deliberate effort the instincts of their descendants. All the knowledge and all the resource of mind which is involved in these instincts is a reflection of some Agency which is outside the creatures which exhibit them. In this respect it may be said with truth that they are machines. But then they are machines with this peculiarity, that they not only reflect, but also in various measures and degrees partake of, the attributes of mind. It is always by some one or other of these attributes that they are guided—by fear, or by desire, or by affection, or by mental impulses which go straight to the results of reasoning without its processes. That all these mental attributes are connected with a physical organism which is constructed on mechanical principles, is not a matter of speculation. It is an obvious and acknowledged fact. The question is not whether, in this sense, animals are machines, but whether the work which has been assigned to them does or does not partake in various measures and degrees of the various qualities which we recognize in ourselves as the qualities of sensation, of consciousness, and of will.

On this matter it seems clear to me that Professor Huxley has seriously misconceived the doctrine of Descartes. It is true that he quotes a passage as representing the view of "orthodox Cartesians," in which it is asserted that animals "eat without pleasure and cry without pain," and that they "desire" nothing as well as "know" nothing. But this passage is quoted, not from Descartes, but from Malebranche. Malebranche was a great man; but on this subject he was the disciple and not the master; and it seems almost a law that no utterance of original genius can long escape the fate of being travestied and turned to nonsense by those who take it up at second hand. Descartes' letter to More of the 5th Feb., 1649, proves conclusively that he fully recognized in the lower animals the existence of all the affections of mind except "Thought" (la Pensée), or Reason properly so called. He ascribes to them the mental emotions of fear, of anger, and of desire, as well as all the sensations of pleasure and of pain. What he means by Thought is clearly indicated in the passage in which he points to Language as the peculiar product and the sole index of thought—Language, of course, taken in its broadest sense, signifying any system of signs by which general or abstract ideas are expressed and communicated. This, as Descartes truly says, is never wanting even in the lowest of men, and is never present, even in the highest of the brutes. But he distinctly says that the lower animals, having the same organs of sight, of hearing, of taste, etc., with ourselves, have also the same sensations, as well as the same affections of anger, of fear and of desire—affections which, being mental, he ascribes to a lower kind of class of Soul, an "âme corporelle." Descartes, therefore, was not guilty of confounding the two elements of meaning which are involved in the word machine—that element which attaches to all human machines as consisting of dead non-sentient matter—and that other element of meaning which may be legitimately attached to structures which have been made, not to simulate, but really to possess all the essential properties of life. "Il faut pourtant remarquer," says Descartes, emphatically; "que je parle de la pensée, *non de la vie, ou de sentiment.*" *

The experiments quoted by Professor Huxley and by other Physiologists, on the phenomena of vivisection, cannot alter or modify the general conclusions which have long been reached on the unquestionable connection between all the functions of life and the mechanism of the body. The question remains whether the ascertainment of this connection in its details can alter our conceptions of what life and sensation are. No light is thrown on this question by cutting out from an organism certain parts of the machinery which are known to be the seat of consciousness, and then finding that the animal is still capable of certain movements which are usualy indicative of sensation and of purpose. Surely the reasoning is bad which argues that because a given movement goes on after the animal has been mutilated, this movement must therefore continue to possess all the same elements of character which accompanied it when the animal was complete. The character of purpose in one sense or another belongs to all organic movements whatever—to those which are independent of conscious sensation, or of the will, as well as to those which are voluntary and intentional. The only difference between the two classes of movement is that in the case of one of them the purpose is wholly outside the animal, and that in the case of the other class of movement, the animal has faculties which make it, however indirectly, a conscious participant or agent in the purpose, or in some part of the purpose, to be subserved. The action of the heart in animals is as certainly "purposive" in its character as the act of eating and deglution. In the one the animal is wholly passive—has no sensation, no consciousness, however dim. In the other movement the animal is an active agent, is impelled to it by desires which are mental affections, and receives from it the appropriate pleasure which belongs to consciousness and sensation. These powers themselves, however, depend, each of them, on certain bits and parts of the animal mechanism; and if these parts can be separately injured or destroyed, it is intelligible

* Œuvres de Descartes (Cousin), vol. x. p. 205 et seq.

enough that consciousness and sensation may be severed for a time from the movements which they ordinarilly accompany and direct. The success of such an experiment may teach us much on the details of a general truth which has long been known—that conscious sensation inseparably connected with the mechanism of an organic structure. But it cannot in the slightest degree change or modify our conception of what conscious sensation in itself is. It is mechanical exactly in the same sense in which we have long known it to be so—that is to say, it is the result of life working in and through a structure which has been made to exhibit and embody its peculiar gifts and powers.

Considering, now, that the body of Man is one in structure with the body of all vertebrate animals—considering that as we rise from the lowest of these to him, who is the highest, we see this same structure elaborated into closer and closer likeness, until every part corresponds, bone to bone, tissue to tissue, organ to organ—I cannot doubt that Man is a machine, precisely in the same sense in which animals are machines. If it is no contradiction in terms to speak of a machine which has been made to feel and to see, and to hear and to desire, neither need there be any contradiction in terms in speaking of a machine which has been made to think, and to reflect, and to reason. These are, indeed, powers so much higher than the others that they may be considered as different in kind. But this difference, however great it may be, whether we look at it in its practical results, or as a question of classification, is certainly not a difference which throws any doubt upon the fact that all these higher powers are, equally with the lowest, dependent on special arrangements in a material organism. It seems to me that the very fact of the question being raised whether Man can be called a machine in the same sense as that in which alone the lower animals can properly be so described, is a proof that the questioner believes the lower animals to be machines in a sense in which it is not true. Such manifestations of mental attributes as they display are the true and veritable index of powers which are really by them possessed and enjoyed. The notion that, because these powers depend on an organic apparatus, they are therefore not what they seem to be, is a mere confusion of thought. On the other hand, when this comes to be thoroughly understood, the notion that Man's peculiar powers are lowered and dishonored when they are conceived to stand in any similar relation to the body must be equally abandoned, as partaking of the same fallacy. If the sensations of pleasure and of pain, and the more purely mental manifestations of fear and of affection, have in the lower animals some inseparable connection with an organic apparatus, I do not see why we should be jealous of admitting that the still higher powers of self-consciousness and reason have in Man a similar connection with the same kind of mechanism. The nature of this connection in itself is equally mysterious, and, indeed, inconceivable in either case. As a matter of fact, we have precisely the same evidence as to both. If painful and pleasurable emotions can be destroyed by the cutting of a nerve, so also can the powers of memory and of reason be destroyed by an injury or disease which affects some bits of the substance of the brain. If, however, the fact of this mysterious connection be so interpreted as to make us alter our conceptions of what self-consciousness and reason, and all mental manifestations in themselves are, then, indeed, we may well be jealous—not of the facts, but of the illogical use which is often made of them. Self-consciousness and reason and affection, and fear, and pain and pleasure, are in themselves exactly what we have always known them to be; and no discovery as to the physical apparatus with which they are somehow connected can throw the smallest obscurity on the criteria by which they are to be identified as so many different phenomena of mind. Our old knowledge of the work done is in no way altered by any new information as to the apparatus by which it is affected. This is the bungle committed by those who think they can found a new Psychology on the knife. They seem to think that sensation and memory, and reasoning and will, become something different from that which hitherto we have known them to be, when we have found out that each of these powers may have some special "seat" or "organ" in the body. This, however, is a pure delusion. The known element in psychology is always the nature of the mental faculty; the unknown element is always the nature of its connection with any organ. We know the operations of our own minds with a fulness and reality which does not belong to any other knowledge whatever. We do not know the bond of union between these operations and the brain, except as a sort of external and wholly unintelligible fact. Remembering all this, then, we need not fear or shrink from the admission that Man is a reasoning and self-conscious machine, just in the same sense in which the lower animals are machines which have been made to exhibit and possess certain mental faculties of a lower class.

But what of this? What is the value of this conclusion? Its value would be small indeed if this conception of ourselves as machines could be defended only by a harmless metaphor. But there is far more to be said for it, and about it, than this. The conception is one which is not only harmless, but profoundly true, as all metaphors are when they are securely rooted in the Homologies of Nature. There is much to be learned from that aspect of mind in which we regard its powers as intimately connected with a material apparatus, and from that aspect of our own bodies in which they are regarded as one in structure with the bodies of the brutes. The significance of it as establishing Man's place in the unity of Nature is altogether independent of any theory or conclusion as to those processes of creation by which his body has been fashioned on a plan which is common to him, and to so many of the animals beneath him. Whether Man has been separately created out of the inorganic elements of which his body has been composed, or whether it was created out of matter previously organized in lower forms, this community of form must equally indicate a corresponding community of relations with external things, and some antecedent necessity deeply seated in the very nature of those things, why his bodily frame should be like to theirs.

And, indeed, when we consider the matter, it is sufficiently apparent that the relationship of Man's body to the bodies of the lower animals is only a subordinate part and consequence of that higher and more general relationship which prevails between all living things and those elementary forces of Nature which play in them, and around them, and upon them. If we could only know what that relationship is in its real nature, and in its full extent, we should know one of the most inscrutable of all secrets, for that secret is no other than the ultimate nature of life. The great matter is to keep the little knowledge of it which we possess safe from the effect of deceptive definitions. Attempts to define life are generally worse than useless, because they almost always involve a deliberate attempt to shut out from view some one or more of the elements which are essential to our own knowledge of its attributes. The real unities of Nature will never be reached by confounding her distinctions. It may be legitimate to reduce the phenomena of life to its lowest terms, in order the better to conceive its relations with other things. But in doing so we must take care not to drop out of those terms anything really essential to the very idea of life. It is very easy to deceive ourselves in this way—very easy by mere artifices of language to obliterate the most absolute distinctions which can exist in thought. Between the living and the not-living there is a great gulf fixed, and the indissoluble connection which nevertheless exists between them is, like the other unities of Nature, not founded upon sameness, but, on the contrary, rather upon difference, and even upon antagonisms. Only the forces which are thus different and opposed are subject to a power of co-ordination and adjustment. But this is the fundamental conception of a machine. For we must not fail to notice the kind of unity which is implied in the words co-ordination and adjustment; and, above all others, in the special adjustment connected with organic life. There are many unions which do not involve the idea of adjustment, or which involve it only in the most rudimentary form. The mere chemical union of two or more elements—unless under special conditions—is not properly an adjustment. We should not naturally call the formation of rust an adjustment between the oxygen of the atmophere and metallic iron. When the combinations effected by the play of chemical affinities are brought about by the selection of elements so placed within reach of each other's reactions as to result in a given product, then that product would be accurately described as the result of co-ordination and adjustment. But the kind of co-ordination and adjustment which appear in the facts of life is of a still higher and more complicated kind than this. Whatever the relationship may be between living organisms and the elements, or elementary forces of external nature, it certainly is not the relationship of mere chemical affinities. On the contrary, the unions which these affinities themselves produce can only be reached through the dissolution and destruction of living bodies. The subjection of chemical forces to the maintenance of a seperate individuality is of the very essence of life. The destruction of that separateness is of the very essence of death. It is not life, but the cessation of life, which, in this sense and after this manner, unites the elements of the body with the elements around it. There is indeed an adjustment—a close and intricate adjustment—between these and the living body; but it is an adjustment of them under the controlling energy of a power which cannot be identified with any other, and always presents phenomena peculiar to itself. Under that power we see that the laws and forces of chemical affinity, as exhibited apart from life, are held, as it were, to service—compelled, indeed, to minister, but not allowed to rule. Through an infinite variety of organisms, this mysterious subordination is maintained, ministering through an ascending series to higher and higher grades of sensation, perception, consciousness, and thought.

And here we come in sight of the highest adjustment of all. Sensation, perception, consciousness, and thought, if they be not the very essence of life, are at least in their order its highest accompaniment and result. They are the ultimate phenomena, if they be not the final realities, to which all the lesser adjustments are themselves adjusted. For as the elementary substances and the elementary forces of Nature which are used in the building of the body are they held by the energies of life under a special and peculiar relation to those same elements outside the body, so also are they held in peculiar relations to those characteristic powers which are the rudimentary faculties of mind.

It is the unity which exists between the living organism and the elements around it which renders that organism the appropriate channel of communication with the external world, and a faithful interpreter of its signs. And this the organism is, not only by virtue of its substance and composition, but also and especially by virtue of its adjusted structures. All the organs of sense discharge their functions in virtue of a mechanical adjustment between the structure of the organ and the particular form of external force which it is intended to receive and to transmit. How fine those adjustments are can best be understood when we remember that the retina of the eye is a machine which measures and distinguishes between vibrations which are now known to differ from each by only a few millionths of an inch. Yet this amount of difference is recorded and made instantly appreciable in the sensations of color by the adjusted mechanism of the eye. Another adjustment, precisely the same in principle, between the vibrations of sound and the structure of the ear, enables those vibrations to be similarly distinguished in another special form of the manifold language of sensation. And so of all the organs of sense—they all perform their work in virtue of that purely mechanical adjustment which places them in a given relation to certain selected manifestations of external force, and these they faithfully transmit according to a code of signals the nature of which is one of the primary mysteries of life, but the truthfulness of which is at the same time one of the most certain of its facts.

For it is upon this truthfulness—that is to say, upon a close and efficient correspondence between the impressions of sense and the realities of external nature—that the success of every organism depends in the battle of life. And all life involves a battle, for though it comes to each animal without effort of its own, it cannot be maintained without individual exertion. That exertion may be of the simplest kind, nothing more than the rhythmic action of a muscle contracting and expanding so as to receive into a sac such substances as currents of water may bring along with them; or it may be the more complex action required to make or induce the very currents which are to bring the food; or it may be the much more complex exertions required in all active locomotion for the pursuit and capture of prey: all these forms of exertion exist, and are all required in endless variety in the animal world. And throughout the whole of this vast series the very life of every creature depends on the perfect correspondence which exists between its sense-impressions and those realities of the external world which are specially related to them. There is therefore no conception of the mind which rests on a broader basis of experience than that which affirms this correspondence to be real—a unity which constitutes and guarantees the various senses, each in its own sphere of adapted relations, to be exact and faithful interpreters of the truth.

Nor is it the least wonderful and striking proof of the trustworthiness of Nature to observe how far-reaching these interpretations are: how they are true not only in the immediate impressions they convey, but true also as the index of truth which lie behind and beyond, but which are not expressly included in either sensation or perception. This, indeed, is one main function and use, and one universal characteristic, of all sense-impresssions, that over and above the pleasure they give to sentient creatures, they lead and guide to acts which are in conformity with the requirements of the natural laws—these laws not being themselves objects of sensation at all—being, on the contrary, truths which the creatures most concerned in the requisite conformity being obeyed cannot themselves either feel or comprehend. It is thus that the appetite of hunger and the sense of taste, which in some form or other, however low, is perhaps the most universal sensation of animal organisms, is true not only as a guide to the substances which do actually give rise to the appropriate pleasure derivable from the sense concerned, but true also in its unseen and unfelt relations with those profound and still mysterious correlations of force which render the assimilation of new material an indispensable necessity in the maintenance of animal life.

The wonderful instincts of the lower animals, the precision and perfection of their work, is a glorious example of the accurate adjustment between the rudimentary perceptions of mind and the laws which prevail in the external world. Narrow as the sphere of those perceptions may be, yet within that sphere they are almost absolutely true. And although the sphere is indeed narrow as regards the very low and limited intelligence with which it is associated in the animals themselves, it is a sphere which beyond the scope of that intelligence can be seen to place them in unconscious relation with endless vistas of co-ordinated action. The sentient actions of the lower animals involve not merely the elementary perception of the differences which distinguish things, but the much higher perception of those relations between them which are the foundation of all voluntary agency, and which place in the possession of living creatures the power of attaining ends through the employment of appropriate means. The direct and intuitive perception of the necessity of doing one thing in order to attain to another thing, is in itself one of the very highest among the pre-adjusted harmonies of Nature. For it must be remembered that those relations between things which render them capable of being used as means to ends are relations which never can be the direct objects of sensation, and therefore a perception of them is an intuition of something which is out of sight. It is a kind of dim mental seeing of that which is invisible. And even if it be separated entirely in the lower animals from any thing comparable with our own self-consciousness, it does not the less involve in them a true reflection of and correlation with the order of Nature and its laws The spinning machinery which is provided in the body of a spider is not more accurately adjusted to the viscid secretion which is provided for it, than the instinct of the spider is adjusted both to the construction of its web and also to the selection of likely places for the capture of its prey. Those birds and insects whose young are hatched by the heat of fermentation have an intuitive impulse to select the proper materials, and to gather them for the purpose. All creatures, guided sometimes apparently by senses of which we know nothing, are under like impulses to provide effectually for the nourishing of their young; and it is most curious and insructive to observe that the extent of provision which is involved in the process, and in securiug of the result, seems very often to be greater as we descend in the scale of nature, and in proportion as the parents are dissociated from the actual feeding or personal care of their offspring. The mammalia have nothing to provide except food for themselves, and have at first, and for a long time, no duty to perform beyond the discharge of a purely physical function. Birds have more to do—in the building of nests, in the choice of sites for these, and after incubation in the choice of food adapted to the period of growth. Insects, much lower in the scale of organization, and subject to the wonderful processes of metamorphosis, have to provide very often for a distant future, and for successive stages of development not only in the young but in the *nidus* which surrounds them. Bees, if we are to believe the evidence of observers, have an intuitive guidance in the selection of food which has the power of producing organic changes in the bodies of the young, even to the determination and development of sex. so that, by the administration of it under what may be called artificial conditions, certain selected individuals can be made the mothers and queens of future hives. These are but a few examples of facts of which the whole animal world is full, presenting, as it does, one vast series of adjustments between bodily organs and corresponding instincts. But this adjustment would be useless unless it were part of another adjustment—between the instinct and the perceptions of animals and those facts and forces of surrounding nature which are related to them, and to the whole cycle of things of which they form a part. In those instinctive actions of the lower animals which involve the most distant and the most complicated anticipations, it is certain that the prevision involved is a prevision which is not in the animals themselves. They appear to be, and beyond all doubt really are, guided by some simple appetite, by an odor or a taste, and, in all probability, they have generally as little consciousness of the ends to be subserved as the suckling has of the processes of nutrition. The path along which they walk is a path which they did not engineer. It is a path made for them, and they simply follow it. But the propensities and tastes and feelings which make them follow it, and the rightness of its direction towards the ends to be attained, do constitute an adjustment which may correctly be called mechanical, and is part of a unity which binds together the whole world of life, and the whole inorganic world on which living things depend.

Surely, then, it would be a strange object of ambition to try to think that we are not included in this vast system of adjustment; that our nobler faculties have no share in the secure and wonderful guarantee which it affords for the truthfulness of all mental gifts. It is well that we should place a high estimate on the superiorities of the powers which we possess; and that the distinction, with all its consequences, between self-conscious reason and the comparatively simple perceptions of the beasts, should be ever kept in view. But it is not well that we should omit from that estimate a common element of immense importance which belongs to both, and the value of which becomes immeasurably greater in its connection with our special gifts. That element is the element of adjustment—the element which suggest the idea of an apparatus—the element which constitutes all our higher faculties—the index and the result of a pre-adjusted harmony. In the light of this conception we can see a new meaning in our "place in Nature;" that place which, so far as our bodily organs are concerned, assigns to us simply a front rank among the creatures which are endowed with life. It is in virtue of that place and association that we may be best assured that our special gifts have the same relation to the higher realities of nature which the lower faculties of the beasts have to the lower realities of the physical world. Whatever we have that is peculiar to ourselves is built up on the same firm foundation on which all animal instinct rests. It is often said that we can never really know what unreasoning instinct is, because we can never enter into an animal mind, and see what is working there. Men are so apt to be arrogant in philosophy that it seems almost wrong to deprecate even any semblance of the consciousness of ignorance. But it were much to be desired that the modesty of philosophers would come in the right places. I hold that we can know, and can almost thoroughly understand, the instincts of the lower animals; and this for the best of all reasons, that we are ourselves animals, whatever more;—having, to a large extent, precisely the same instincts, with the additional power of looking down upon ourselves in this capacity from a higher elevation to which we can ascend at will. Not only are our bodily functions precisely similar to those of the lower animals,—some, like the beating of the heart, being purely "automatic" or involuntary—others being partially, and others again being wholly, under the control of the will,—but many of our sensations and emotions are obviously the same with the sensations and emotions of the lower animals, connected with precisely the same machinery, presenting precisely the same phenomena, and recognizable by all the same criteria.

It is true that many of our actions become instinctive and mechanical only as a result of a previous intellectual operation of a self-conscious or reasoning kind. And this no doubt is the origin of the dream that all instinct, even in the animals, has had the same origin; a dream due to the exaggerated "anthropomorphism" of those very philosophers who are most apt to denounce this source of error in others. But Man has many instincts like the animals, to which no such origin in previous reason can be assigned. For not only in the earliest infancy, but throughout life, we do innumerable things to which we are lead by purely organic impulse; things which have indeed a reason and a use, but a reason which we never know, and a use which we never discern, till we come to "think." And how different this process of "thinking" is we know likewise from our own experience. In contemplating the phenomena of reasoning and of conscious deliberation it really seems as if it were impossible to sever it from the idea of a double Personality. Tennyson's poem of the "Two Voices" is no poetic exageration of the duality of which we are conscious when we attend to the mental operations of our own most complex nature. It is as if there were within us one Being always receptive of suggestion, and always responding in the form of impulse—and another Being capable of passing these suggestions in review before it, and of allowing or disallowing the impulses to which they give rise. There is a profound difference between creatures in which one only of these voices speaks, and Man, whose ears are, as it were, open to them both. The things which we do in obedience to the lower and simpler voice are indeed many, various, and full of a true and wonderful significance. But the things which we do, and the affections which we cherish, in obedience to the higher voice, have a rank, a meaning, and a scope which is all their own. There is no indication in the lower animals of this double Personality. They hear no voice but one; and the whole law of their

Being is perfectly fulfilled in following it. This it is which gives its restfulness to Nature, whose abodes are indeed what Wadsworth calls them—

"Abodes in which Self-disturbance hath no part."

On the other hand the double Personality, the presence of "Two Voices," is never wholly wanting even in the most degraded of human beings—their thoughts everywhere "accusing or else excusing one another."

Knowing, therefore, in ourselves both these kinds of operation, we can measure the difference between them, and we can thoroughly understand how animals may be able to do all that they actually perform, without ever passing through the processes of argumentation by which we reach the conclusions of conscious reason and of moral obligation. Moreover, seeing and feeling the difference, we can see and feel the relations which obtain between the two classes of mental work. The plain truth is, that the higher and more complicated work is done, and can only be done, with the material supplied by the lower and simpler tools. Nay, more, the very highest and most aspiring mental processes rest upon the lower, as a building rests upon its foundation-stones. They are like the rude but massive substructions from which some great Temple springs. Not only is the impulse, the disposition and the ability to reason as purely intuitive and congenital in Man as the disposition to eat, but the fundamental axioms on which all reasoning rests are, and can only be, intuitively perceived. This, indeed, is the essential character of all the axioms or self-evident propositions which are the basis of reasoning, that the truth of them is perceived by an act of apprehension, which, if it depends on any process, depends on a process unconscious, involuntary, and purely automatic. But this is the definition, the only definition, of instinct or intuition. All conscious reasoning thus starts from the data which this great faculty supplies; and all our trust and confidence in the results of reasoning must depend on our trust and confidence in the adjusted harmony which has been established between instincts and the truths of Nature. Not only is the idea of mechanism consistent with this confidence, but it is inseparable from it. No firmer ground for that cofidence can be given us in thought then this conception,—that as the eye of sense is a mechanism specially adjusted to receive the light of heaven, so is the mental eye a mechanism specially adjusted to perceive those realities which are in the nature of necessary and eternal truth. Moreover, the same conception helps us to understand the real nature of those limitations upon our faculties which curtail their range, and which yet, in a sense, we may be said partially to overpass in the very act of becoming conscious of them. We see it to be a great law prevailing in the instincts of the lower animals, and in our own, that they are true not only a guiding the animal rightly to the satisfaction of whatever appetite is immediately concerned, but true also as ministering to ends of which the animal knows nothing, although they are ends of the highest importance, both in its own economy, and in the far-off economies of creation. In direct proportion as our own minds and intellects partake of the same nature, and are founded on the same principle of adjustment, we may feel assured that the same law prevails over their nobler work and functions. And the glorious law is no less than this—that the work of Instinct is true not only for the short way it goes, but for that infinite distance into which it leads in a true direction.

I know no argument better fitted to dispel the sickly dreams of the Philosophy of Nescience. Nor do I know of any other conception as securely founded on science, properly so called, which better serves to render intelligible, and to bring within the familiar analogies of Nature, even those highest and rarest of all gifts which constitute what we understand as inspiration. That the human mind is always in some degree, and that certain individual minds have been in a special degree, reflecting surfaces, as it were, for the verities of the unseen and eternal world, is a conception having all the characters of coherence which assures us of its harmony with the general constitution aud course of things.

And so, this doctrine of animal automatonism—the notion that the mind of Man is indeed a structure and a mechanism—a notion which is held over our heads as a terror and a doubt—becomes, when closely scrutinized, the most comforting and reassuring of all conceptions. No stronger assurance can be given us that our faculties, when rightly used, are powers on which we indeed rely. It reveals what may be called the strong physical foundations on which the truthfulness of reason rests. And more than this—it clothes with the like character of trustworthiness every instinctive and intuitive affection of the human soul. It roots the reasonableness of faith in our conviction of the Unities of Nature. It tells us that as we know the instincts of the lower animals to be the index and the result of laws which are out of sight to them, so also have our own higher instiets the same relation to truths which are of corresponding dignity, and of corresponding scope.

Nor can this conception of the mind of Man being inseparably connected with an adjusted mechanism cast, as has been suggested, any doubt on the freedom of the will,—such as by the direct evidence of consciousness we know that freedom to be. This suggestion is simply a repetition of the same inveterate confusion of thought which has been exposed before. The question what our powers are is in no way affected by the admissson or discovery that they are all connected with an apparatus. Consciousness does not tell us that we stand unrelated to the system of things of which we form a part. We dream—or rather, we simply rave—if we think we are free to choose among things which are not presented to our choice—or if we think that choice itself can be free from motives,—or if we think that we can find any motive outside the number of those to which by the structure of our minds and of its organ we have been made accessible. The only freedom of which we are really conscious is freedom from compulsion in choosing among things which are presented to our choice,—consciousnees also attesting the fact that among those things some are coincident, and some are not coincident with acknowledged obligation. This, and all other direct perceptions, are not weakened but confirmed by the doctrine that our minds are connected with an adjusted mechanism. Because the first result of this conception is to establish the evidence of consciousness when given under healthy conditions, and when properly ascertained, as necessarily the best and the nearest representation of the truth. This it does in recognizing ourselves, and all the faculties we possess, to be nothing but the result and index of an adjustment contrived by, and reflecting the Mind which is supreme in Nature. We are derived and not original. We have been created, or—if any one likes the phrase better—we have been "evolved;" not, however, out of nothing, nor out of confusion, nor out of lies,—but out of "Nature," which is a word for the Sum of all Existence,—the source of all Order and the very ground of all Truth,—the Fountain in which all fullness dwells.

Thus the doctrine which at first sight seems so terrible turns out to be nothing but one intellectual aspect of the many-sided moral truth which of old found expression in the *Non nobis, Domine.*—*Contemporary Review.*

Note on the Manufacture of Stone Axes. BY E. W. CLAYPOLE, *B. A. B. Sc.*, Antioch College.

Some discussion has at different times been raised concerning the process by which the savage tribes, who used the stone weapons now so common inour Archæological Museums, bored the holes, through the hammer and axe-heads into which the handles were put. The greater part of these tools and weapons were doubtless attached to the ends of split sticks and secured by withes. But not a few are pierced from side to side with a clean and round hole. The sides of this hole, on inspection, show a set of circular markings, proving that it was drilled out by some implement which was kept in rotatory motion. But the exact nature of the instrument and the method of using it are yet quite undetermined.

Some years ago, the writer was spending a morning, in the Archæological Museum in Edinburgh, with the Curator, Mr. Anderson, when this subject came up. It was suggested by the sight of a piece of stone, unique, in the collection, nearly cylindrical in shape about an inch in diameter, and rubbed at one end, so that it was quite smooth and polished. At the same time the smooth end was marked with concentric rings, that immediately suggested to the writer's mind the thought, that it had been used for boring a hole through some other piece of stone. On examining a number of the axe-heads, not one could be found the hole in which it exactly fitted. This fact, however, is by no means conclusive against its having been used for such a purpose.

Being made, I believe, of greenstone, which possesses no grit, it must have been aided by sand. The use of this as an assistant in grinding seems to involve no very high degree of civilization, but I am unable to recollect, if any evidence of its employment for this purpose has been discovered in ancient times, and also if it is now so used by the Indians of this continent, where they exist in their aboriginal condition or nearly so.

Another suggestion has been made concerning the method of boring these axe-heads. I have not the work within reach at present, but it may be found, if I mistake not, in Keller's Lake Dwellings of Switzerland. It is, that the holes were made by means of a cylinder of wood, either hollow or full of pith, like a cane or a piece of alder. This is supposed to have been aided by sand and kept in quick rotation backwards and forwards between the palms of the two hands. No doubt the wood would be worn away much more rapidly than the stone, but it could be readily renewed. This process like the other involves an acquaintance with the use of sand for grinding.

It is obvious, at a glance, that the latter method would be by far the more advantageous of the two, mechanically. It would cut out a hole as large as the former, but the material removed would not all be ground to powder. A core would be left and afterwards broken off in the solid state serving while it remained in the hole to keep the borer in an upright position. The processes exactly resembled (if we compare new things with old) the two methods now in use for sinking deep wells. By one, the whole shaft of stone, that occupied the place of the future bore-hole, is pounded into dust by a heavy jumper, and removed as mud by the help of water. By the other the boring tool only cuts round a core, which is removed, afterwards, entire and lifted out of the hole.

Being lately at Princeton and looking over a large collection of relics from the Swiss Lakes recently purchased and imported by Professor Guyot, the fact mentioned above was strongly recalled to my mind by seeing among them some small pieces of stone which exactly resembled the cores that would be produced by boring out a stone, tool or weapon in the manner just described. They were roughly cylindrical, about half or three-quarters of an inch in diameter, and nearly an inch long, marked with rings in such a manner as to irresistibly call up the thought, that they were the cores left in boring round holes through pieces of stone. In trying to fit them into the stone axe-heads, with the aid of the curator, I was, as might be expected, not very successful. The cores being too large for the holes. It was hardly to be expected that weapon and core should after so many ages and so many accidents have found their way to the same cabinet. But the probability nevertheless appears very high that such specimens are related to each other in the way above suggested. The hole in an axe-head, as every collector knows well, is never of the same diameter throughout. It is larger outside and then diminishes inwardly to the middle, where it is smaller. This would naturally result, if they were bored in this way. Let any one take a piece of cane or alder and try with sand to drill a piece of stone, and he will find, that owing to the difficulty of keeping the boring-tool perfectly upright the hole will widen somewhat as it grows deeper. The process appears to have been to bore to the middle and then break off the core and begin on the other side and accordingly the cores, if such they be, seldom exceed in length about one-half of the thickness of an axe-head.

The relics, which I have just described (and that at Princeton College) are from the Swiss Lake Dwellings. My own collection and knowledge of North American relics is small and I am not able to determine how far the supposition, I have above mentioned, may be in accordance with observations máde upon these by students more familiar with North American archæology. I rather make the suggestion in the hope that some of them may bring forward facts in favor or in opposition. The early races of men seem to have trodden paths marvellously similar though in countries very distant from each other, and it may be, that one or both of these methods of drilling stone-axes was made use of by the aborigines of this continent.

Perhaps some of the readers of the Cincinnati Quarterly Journal of Science may be able to quote examples of these supposed cores, and to describe them in some future number.

New Species of Trilobite from the Trenton Limestone at Trenton Falls, N. Y. By C. D. Walcott.

Genus *Remopleurides*—(Portlock.)

R. striatulus, (n. sp.)

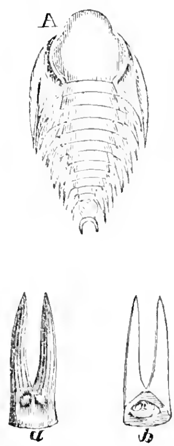

Fig. 27. *Remopleurides striatulus.* a Anterior surface of hypostoma. b Ventral surface of hypostoma. The hypostoma figured is of the same size as that of the trilobite A.

General form obovate, strongly convex. Head subrotund. Glabella prominent, central portion slightly convex, broadest at the posterior third, contracted at the base, where the width is the same as at the anterior margin of the eyes. A narrow palpebral lobe encircles the lateral margins two-thirds the length of the head. Anterior margin narrows and curves abruptly downward. Three pair of glabellar furrows are indicated by smooth lines; anterior and posterior very obscure. Neck segment narrow, well defined from the glabella by being slightly depressed; a minute tubercle occurs upon the anterior central third.

Movable cheeks; upper margin forms the base of the eye; anteriorly an acute angle terminating under the anterior base of the eye; posterior margin with two spines; the inner short, sharp pointed, curves downward and backward on a line with the pleura of the first segment of the thorax; outer spine long, nearly flat, obliquely striated, terminates opposite the axial lobe of the fifth segment.

At the anterior base of the eyes the outer margin of the movable cheeks curve abruptly downward and under forming a doublure, which extends around under the anterior margin of the glabella, and backward under the cheeks to a line with the neck segment.

Eyes large, elongated, depressed, occupy the curved space between the upper margins of the cheeks and the lateral margins of the glabella: perpendicular in hight to each, surface finely reticulated.

Facial sutures cutting the neck segment on a line with the base of the eyes, extend obliquely up to the posterior lateral angles of the glabella; curve outward around the top of the eyes, then abruptly down forming their anterior margin, curving forward and slightly upward they unite in front of the glabella.

Hypostoma; body quadrate, buccal margin produced into two long tapering lobes, with a deep buccal notch between them; upon the ventral surface four elevated lines run the length of each lobe, two central and one on each margin, the marginal lines of the outer margins continue to the anterior margin of the body, three short lines separating them near the anterior margin; muscular scars slightly elevated, oval, situated anterior to the buccal notch, they are crossed by minute inosculating lines. Interior or dorsal surface of the body cut away anteriorly forming a semi-circular depression, showing the interior of the ventral surface, and muscular scars as slight depressions crossed by minute striæ; ventral surface minutely tubercular, interior surface smooth. The hypostoma was attached to the doublure beneath the glabella; the extremities of the buccal lobes extending back to the anterior edge of the seventh thoracic segment.

Thorax with ten segments arching forward, narrows rapidly to the pygidium; axial lobe separated from the plural lobes, by a sharp ridge extending two-thirds the distance across each segment, a slight diagonal furrow crosses the segments of the axial lobe near the junction of the axial and plural lobes. Pluræ flat, curving down one-half the way outward where they are reflected backward, terminating in short pointed extremities.

Pygidium small, subquadrate, posterior margin narrowing is divided by a semi-circular depression into two short abruptly attenuate points, obliquely striated from the medial line backwards.

Surface. Glabella finely tuberculated. Movable cheeks very finely granulated. Axial lobe smooth with a few fine punctures. Outer spines of the head, pleuræ, (outer and inner surface), and pygidium striated.

Formation and locality. Upper third of the Trenton Limestone, Trenton Falls, N. Y. The glabella of this species closely resembles the glabella described by Prof. E. Billings as Remopleurides Canadensis, from the Chazy Limestone. Differs in the narrow palpebral lobes and glabellar furrows.

Some New Species of Fossils from the Cincinnati Group and Remarks upon some Described Forms. *By* S. A. Miller.

Acidaspis anchoralis (n. sp.)

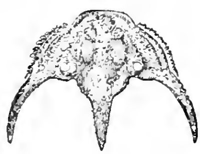

Fig. 23: Head of Acidaspis anchoralis.

Fig. 24. Pygidium.
[Etym, *anchoralis* anchor shaped.]

Cephalic shield, irregular, rough, tuberculated and spinous. An outline of the margin would be represented by a depressed arc in front, a slightly longer digitated and expanded arc for each cheek, and a still longer arc for each of the projecting spines, while a half ellipse would be formed between the projecting spine from the occipital part of the glabella and each of the cheek spines. The cheeks have about twelve or fourteen digitations or short curved spines on the lateral margins, and about twenty prominent tubercles on the face of each, with their posterior extremities produced, in a strong, round, oblique, curving spine covered with numerous smaller tubercles or asperities. The eyes are prominent, directed backwards, and situated near the posterior junction of the cheeks with the glabella. The glabella is somewhat anchor shaped in outline; the middle lobe has an expanded elevation in front just back of the front marginal furrow and is projected posteriorly over the middle lobe of the thorax in a strong curving tuberculated spine of equal or greater length than the spines projecting from the cheeks. There are two lateral lobes on each side of the middle one; the anterior ones are somewhat circular with about ten or twelve tubercles on each; the posterior ones are subelliptical, bear from twelve to twenty tubercles and extend back between the anterior parts of the eye tubercles and the middle lobe. A curved row of tubercles starting from the inner lateral side of each eye terminate even with the anterior lateral lobe of the glabella (in some specimens there are two rows) and another curved row starting from the anterior part of the eye and running parallel with the former terminates with the expanded front of the middle lobe just forward of the anterior lateral lobe.

Thorax unknown.

Pygidium known only from a view of the under surface as shown by the figure. It appears to be more than twice as wide as long and to bear two strong diverging slightly curving spines, which take their rise from the sides of the last segment in the mesial lobe. These spines are covered with tubercles. Between these spines there are six prominent tubercles, four of which seem to have borne very short spines, and to be visible from the opposite side, the other two placed at the lower part of the base of the spines, and on each side of the strong curving spines there are three short spines.

The figures are drawn natural size, but it is not an uncommon occurence to find the glabella, with its produced spine, much longer than it is in the specimen figured. The specimens figured are from the same slab, collected by me, in Judge Collin's quarry, at an elevation of about 340 feet. I have found tolerably good specimens of the glabella on the top of the hill in Mt. Auburn, at an elevation of about 400 feet, above low water mark.

Beyrichia Cincinnatiensis (n. sp.)

Fig. 25. Beyrichia Cincinnatiensis.

This is the smallest *Beyrichia*, known to me, in the Cincinnati rocks. It belongs to the unisulcate group of "simplices," and is very closely related to the *Leperditia*. General form, elliptical, with a straight dorsal edge. Surface of the valves smooth, convex, with a single depression extending from the middle of the dorsal margin across about or a little over half the breadth of each valve. Ventral and terminal margins bordered by a very narrow depressed rim.

Length of specimen about $\frac{2}{100}$ inch; breadth about two thirds the length.

It is found associated with *B. quadrilirata,* on slabs, about three miles east of Weisburg on the I. & C. R. R., and with the same fossil and *B. Chambersi,* about two miles north-east of Fort Ancient, on the L. M. R. R. The rocks at each of these places are about 300 feet below the upper silurian.

Leperditia cylindrica (HALL.)

This species is distributed throughout the rocks of the Cincinnati Group, and is quite variable in form and size. It was described from cylindrical specimens, only about two hundredths of an inch in length; but forms five hundredths or six hundredths of an inch in length, and having the anterior third much enlarged, making a club shaped shell, by reason of the minute gradations from one extreme to the other, may be classified with it. The largest and best club shaped specimens, I found abundant, on rocks, in the run, on the O. & M. R. R., 1½ miles east of Laughery creek, or about 44 miles west of Cincinnati. At first, I was disposed to treat this latter form as sufficiently distinct to warrant me in naming it; but after an examination of large numbers, I came to the conclusion, that I was unable to separate it, by any constant characters.

Beyrichia ciliata (EMMONS.)

This species, described by Prof. Emmons, in his American Geology, from the Blue limestone of Ohio, I believe, is the same, that was described, by Prof. Hall, many years later, under the name of *B. tumifrons.* Emmons figured the interior and Hall the exterior, but there does not seem to be much difficulty, in determining the fossil, from Emmons' figure and description, moreover, there is no other form, known in the Blue limestone of this locality, that could for a moment be confounded with it.

Beyrichia regularis (EMMONS.)

This species was described by Prof. Emmons, in his American Geology from the Blue limestome of Ohio, and though his figure is not very good, I know of no form so closely related to it, as *B. quadrilirata* of Hall and Whitfield, in the 2nd volume of Ohio Paleontology. The latter name will be found, probably, to be a synonym.

Calamopora fibrosa (Goldfuss.)

This species was placed by Prof. McCoy in the genus *Stenopora*, where it was left by the Canadian geologists. It is quite likely, that it should be classed in the genus *Monticulipora* and this would seem to be the opinion of Edwards and Haime, certain, it is, however, that it does not belong to the genus *Chetetes*. And I have elsewhere shown, that there are no Corals, found in the Cincinnati Group, belonging to the genus *Chetetes*. It was described from specimens, obtained by Goldfuss, from this vicinity, and there does not appear to me to be any difficulty in identifying it. But Prof. Nicholson, after examining the corals of this vicinity, says he can not find it. He finds, however, *Monticulipora pulchella* of Edwards and Haime, which is the same fossil, that I have been labelling *Stenopora fibrosa* or *Monticulipora fibrosa* for the past five years, and which is the same, that Billings and the other Canadian geologists have called *fibrosa* in Canada. This species is a common form in the Trenton limestone of Canada and in the Trenton limestone of Minnesota and Wisconsin, and is distributed throughout the rocks, that we now call the Cincinnati Group, which, in their lower exposure, are the equivalent of the Trenton rocks, and in their upper exposure are the equivalent of the Hudson River Group. The corallum forms cylindrical or subcylindrical branches from less than one-fourth of an inch to an inch and a half in diameter and is composed of polygonal, thin-walled corallites. It may be readily distinguished from all other corals, with the aid of a magnifier, by the well marked groups, on the surface, of larger sized corallites. The same fossil in palmate or lobate form is identified by Prof. Nicholson as *Monticulipora mammulata* of D, Orbigny, and the massive and hemispheric forms, have long been known as *lycoperdon* of Say. Prof. Nicholson has made a species, *subpulchellus*, which is distinguished from *fibrosa*, only on the ground, that a few small corallites form the center of each group of large corallites. If this distinction is sufficient to found a species upon, then two more species may be provided, for the palmate, massive and hemispheric forms that are distinguished from the *mammulata* and *lycoperdon* by the same differences. Prof. Nicholson has founded another species, which he has called *Chetetes attritus*, upon no other ground, that I can discover, than the fact, that there are small crystalline prominences on the surface, at the junction of the corallites, on specimens, that have the appearance to thenaked eye of being weather worn, and that appear more distinctly to be surface worn, with the aid of an ordinary magnifier. I do not know why the small points of lime should crystalize on the surface, at the junction of the corallites, on some specimens of worn *Monticulipora fibrosa*, and not on others, but an examination of several specimens has led me to the conclusion, that such is the fact. In other words, the *attritus* of Nicholson is merely a worn specimen of *fibrosa*.

If Prof. Nicholson is correct in identifying this species with *pulchella* of Edwards and Haime, then *pulchella* is merely a synonym for *fibrosa*, but I am not convinced, that these two names are synonymous, on the contrary, I do not think that *pulchella* is found here, at all. Edwards and Haime had before them many corals from this locality, and as the coral now referred by Prof. Nicholson to their species is the most abundant coral in our rocks, it would seem highly probable, that, they were in possession of it, when they wrote their work on the British corals, in which they frequently referred to localities for species, in America, yet when making the species *pulchella* the only locality mentioned was England. They described *pulchella* as follows:

"Corallum ramose; its branches often somewhat compressed, and from two to four lines in diameter. Tubercles broad not very prominent and somewhat stellated. Calices rather regularly hexagonal and very unequal in size; those that occupy the center of the tubercles about one-fifth of a line in diameter and at least twice as large as those placed in the intervals between the groups thus formed."

Our species is usually much larger than this one, and it is very rare to find the branches compressed; the prominences or tubercles are not stellated; the calices are not regularly hexagonal, though as they are crowded together some of them may be hexagonal, while others are pentagonal or heptagonal or approaching a circle, there being no regularity in their form and no uniformity in their size. In specimens four lines in diameter, the calices, that occupy the center of the tubercles, are from $\frac{1}{6}$ to $\frac{1}{8}$ of a line in diameter; the distance, from the center of one tubercle to the center of the next, is about one line, and the average number of calices, in that distance, is about twelve. Moreover Edwards and Haime distinguished *pulchella* from *Fletcheri*, by the more acute angle of bifurcation of the branches, in the former than in the latter, while no such distinguishing character could be applied to our species, as it bifurcates at all angles. Thus it seems, that our species differs, more or less, in every character, from those ascribed to *pulchella* by its authors.

For these reasons, I do not think, that *pulchella* exists in the Cincinnati Group, and it is quite evident, that the corals referred to this species, by Prof. Nicholson, are the same, that were described by Goldfuss, in 1826, under the specific name *fibrosa*. If the corals referred to do not belong to the genus *Stenopora,* the names should be written *Monticulipora fibrosa* instead of *Chetetes pulchellus* and *Chetetes attritus,* and *Monticulipora subpulchella* instead of *Chetetes subpulchellus.*

Monticulipora Dalei (Edwards and Haime.)

The surface of this species is sometimes covered with conical or elongated tubercles, at other times the eminences consist of transversely elongated ridges, that extend part or all the way round the branches. The latter form Prof. Nicholson identifies as *Monticulipora rugosa* of Edwards and Haime, and he proceeds to point out its distinguishing differences, one of which, he says, is the "greater development of the system of the minute tubuli between the ordinary corallites" in *rugosa,* than is seen in *Dalei.* It has been well known, by the collectors at Cincinnati, for several years, that these two forms are found well developed on the same specimen, some specimens of *Dalei* are rugose others are papillose and other specimens are both papillose and rugose. As a specific name or even as a variety name in classification *rugosa* has no existance, if it is founded alone on specimens from the Cincinnati Group. *Chetetes approximatus* of Nicholson which should be written *Monticulipora approximata,* is never, so far as my observation has extended, covered with elongated tubercles, as in the rugose variety of the *Dalei.* Moreover the *approximata* is found abundant, in the rocks from 300 feet to 350 feet above low water mark, where it is very rare to see a piece of the *Dalei,* while the latter abounds, in the rocks, from 350 to 400 feet above low water mark, where the former is comparatively quite as rare as the latter is, in the rocks first mentioned. I think that *Monticulipora Dalei* and *Monticulipora approximata* are good species, always separable, without the aid of a magnifier, and occupying, in part, a different range of rocks.

Arthraria biclavata (n. sp.)

This fucoid consists of a straight cylindrical stem, with an enlargement at each end, nearly as round as a ball. It has some resemblance in shape to dumb-bells. It shows no structure. It usually consists of the impression, only, in slabs—in this form, it is quite common, at the quarries, on the top of the hill, at the east end of Eden Park, and at the quarry, on McMillan street, near the residence of Mr. Stahl. Sometimes, the cylindrical stem, between the balls, is found in tolerably good condition, but it is quite rare to find even part of a ball in the matrix, and I have never seen a specimen free from a slab. The specimens vary but little in relative proportions, though they differ considerably in size. The specimen figured is from one of the numerous impressions, in the slabs, that make the sidewalk, on Torrence Road near Forest Avenue. It is 4 inches in length; length of cylinder $2\frac{2}{3}$ inches; diameter of ball cavities $\frac{2}{3}$ inch; diameter of cylinder $\frac{1}{5}$ inch.

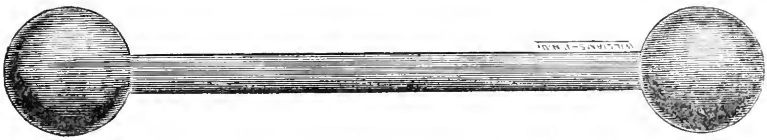

Fig. 26. *Arthraria biclavata.*
[Etym *biclavata*—double clubbed]

The form is constant and prevails, in the rocks, from 300 to 400 feet above low water mark, at Cincinnati, and in the same range in distant quarries. It may have a greater vertical range, though I have never observed it, in either the lower or higher rocks of our Group. As it is found on slabs, exclusively, it does not make a good cabinet specimen and therefore but few have ever been collected.

Sir Charles Lyell.

[From the American Journal of Science and Arts, October, 1875:]

No European geologist was so well known, personally, in the United States as Lyell. His two visits to this country, in 1841 and 1845, recorded in four volumes of travel characterized by great good judgment, large mindedness and catholocity, made his name familiar throughout the land, and gave a degree of popularity here to his philosophical and technical writings which they would otherwise have hardly obtained.

Called by Mr. Lowell to Boston in 1841 to deliver a course of twelve lectures on Geology before the "Lowell Institute," Lyell was the first European, of eminence in science, who appeared upon the platform as a lecturer before an American audience. That his lectures were highly esteemed is well known, and it was a sufficient evidence of this that he was again invited to Boston on a like commission in 1845–6, and before the same institution. The personal relations and friendships commenced on these occasions endured to the end, and were rendered doubly interesting by the charm shed over every social relation by Lady Lyell, who won universal esteem by those qualities of manner which were less prominent in her often abstracted husband. The following familiar private letter from the late Dr. Mantell, written in 1841 to Prof. Silliman (the elder), gives a vivid sketch of Lyell as he appeared to his scientific associates at the time of his first visit to the United States. As all the parties named in this letter are now passed away there can be no objection to its re-production in this connection.

"LONDON, *June* 14th, 1841.

"MY VERY DEAR FRIEND:

"I was about to write you to inform you of Mr. Lyell's intentions which he communicated to me but a short time since. I dined with him last week—a farewell party. His charming little wife, a daughter of Mr. Leonard Horner, accompanies him. I have said so much of you and yours to her that she is quite anxious to visit New Haven; if she does I am sure you will be delighted with her. And now for a strictly private sketch of my old friend. About twenty years or more ago, one beautiful summer evening, a young Scotchman called at Castle Place (Lewes*) and announced himself as Mr. Lyell, stating that he was fond of geology, had been attending Jameson's lectures at Edingburgh, and had visited his former Alma Mater, Midhurst Grammar School, in the west of Sussex; and that, while rambling about the neighborhood, he found some laborers quarrying in stone which they called whin. As this term is *Scoticé* trap, the young traveler was much puzzled to know how such a rock appeared in the south of England, and upon inquiry of one of the laborers why the stone was so called, the man referred him to "a monstrous mon as lived at Lewes, a doctor who knowed all about them things and got curiosities out of the chalk pits to make physic with." The man, in short, had been formerly a Lewes quarryman, and one of my collectors. Mr. Lyell being alone and on horseback and having nothing better to do, rode gently over the South Down, some twenty-five miles, and at the close of the day found himself at my residence. We were mutually pleased with each other; my few drawers of fossils were soon looked over, but we were in gossip until morning, and then commenced a friendship which has continued till now.

Mr. Lyell was educated for the bar. He practiced on the western circuit for seven or eight years, and he allowed me to correspond with him only during the vacations. His father, who is a Scotch Laird, is still living, and there are several sons and daughters. Mr. Lyell is the eldest, and at the death of the father inherits the family estate, which,

*Mantell's place of residence at that time.

I believe, is moderate. However, about seven or eight years after our acquaintance, Mr. Lyell with great good sense, abandoned his profession, with his father's consent, and devoted himself wholly to geology, content with a moderate income, and living in a very unostentatious manner in an unfashionable part of the city. A few years ago he married Miss Horner, who is much younger than himself (Lyell is 45 or 46), and a more suitable companion he could not have found. He has no children. In person, Lyell presents nothing remarkable except a broad expanse of forehead. He is of the middle size, a decided Scottish physiognomy, small eyes, fine chin and a rather proud or reserved expression of countenance. He is very absent, and a slow but profound thinker. He was Professor in King's College, London, and gave lectures there and at the Royal Institution, but it so happened that I never heard him lecture. He always takes part in the discussions at the meetings of the Geological Society, but he has not facility in speaking; there is hesitation in his manner, and his voice is neither powerful nor melodious, nor is his action at all imposing. As a popular lecturer he would stand no chance with Buckland or Sedgwick. He is providing himself with very beautiful illustrations for his lectures at Boston; and I should suppose the prestige of his name and his European reputation will insure him a flattering reception. * * * * There is a hauteur or reserve about Mr. Lyell to strangers that prevents his being so popular among our society as he deserves to be. I believe him to have an excellent heart, and he is very kind and affectionate when his better feelings are called upon." * * * *

This criticism of Lyell's style and manner as a public speaker was certainly well founded, as all will agree who ever heard him lecture. But despite all infelicities, so great was the value and richness of his matter, that he commanded the most respectful and interested attention from his auditors. The reader of his "Principles" could not fail, however, to be struck with the fact that the classic elegance of Lyell's style, for which his more important productions are so justly celebrated, must have been the result of much labor.

We cite from the Geological Magazine edited by Henry Woodward, F. R. S., the following notice of his life and labors. A more elaborate memoir may be expected in the next annual address of the President of the Geological Society of London.

"On Monday, the 22nd of February, at his residence in Harley Street, and in his seventy-eighth year, Sir Charles Lyell, after a long life of scientific labor, passed peacefully from amongst us, to his honored rest.

"To the outside world it may seem strange that the death of a man who was neither statesman, soldier, nor public orator, should arouse our sympathies so strongly, or that he should be so highly esteemed all over the world; but geologists know well what Lyell has done for them since he published the first volume of "The Principles of Geology" in 1830.

"It is in the character of historian and philosophical exponent of geological thought that Lyell has achieved so much for our science: nor can we fail to remember that those clear and advanced views, for which he became so justly celebrated, were advocated by him forty-five years ago, at a time when scientific thought was still greatly trammelled by a strong religious bias, and men did not dare to openly avow their belief in geological discoveries nor accept the only deduction which could be drawn from them.

"Born at Kinnordy, his father's seat near Kerriemuir, in Forfarshire, on the 14th of November, 1797, Lyell received his early education at a private school at Midhurst, and completed it at Exeter College, Oxford, where he took his Bachelor's degree in 1819, obtaining a second-class in Classical honors in Easter Term. On leaving the University, he studied for the Bar, but never practised that profession, his tastes having been led by Dr. Buckland's lectures to the study of geology as a science. In 1824 he was eectled an Honorary Secretary of the Geological Society of London, of which he was one of the earliest Fellows. On the opening of King's College, London, a few years later, he was appointed its first Professor of Geology. He had already contributed some important papers to the "Transactions" of the Geological Society, including one "On a Recent Formation of Freshwater Limestone in Forfarshire, and on some Recent Deposits of Freshwater Marl, with a comparison of recent with ancient Freshwater Formations, and an appendix on *Gyrogonites*, or Seed-Vessels of Chara;" also one "On the Strata of the Plastic Clay Formation exhibited in the Cliffs between Christchurch Head, Hampshire, and Studland Bay, Dorsetshire;" another "On the Freshwater Strata of Hordwell Cliff, Beacon Cliff, and Barton Cliff, Hampshire;" and an elaborate paper on the "Belgian Tertiaries." In 1827 he contributed to the *Quarterly* a review of Mr. Poulett Scrope's "Geology of Central France" (the perusal of which is said first to have stimulated him to prepare and publish "The Principles of Geology" on which his reputation as a philosophical writer mainly rests). These lesser works all showed a power of observation and of generalization which prepared the learned world for some greater and more important treatise from his pen, which should deal, not with local details, but with the general principles of the science. Nor were they disappointed when his *magnum opus*, "The Principles of

Geology," appeared in three successive installments, published respectively in 1830, 1832, and 1833. The work, subsequently enlarged into two volumes, has passed through numerous editions, and is still in as much demand as ever among students of the science. The work was subsequently divided into two parts, which have been published as distinct books, viz. "The Principles of Geology," or the Modern Changes of the Earth and its Inhabitants, as illustrative of Geology," and secondly, "The Elements of Geology, or the Ancient Changes of the Earth and its Inhabitants, as illustrated by its Geological Monuments." The substance of the last-named work has also been published under the title of "The Manual of Elementary Geology," a French translation of which was issued under the auspices of the famous Arago.

"Already, some time previous to the publication of this work, Mr. Lyell had been chosen a Vice-President of the Geological Society; and in 1828 he had undertaken a journey into the volcanic regions of Central France, visiting Auvergne, Cantal, and Velay, and continuing his journey to Italy and Sicily. He published the results of this expedition in the "Edinburg Philosophical Transactions," and also in the "Anales des Science Naturelles."

"It was, however, the publication of his "Principles of Geology" that gave him that established reputation which he ever since continued to enjoy. "Which of us," asked Prof. Huxley, in his Anniversary Address to the Geological Society in 1869," "has not thumbed every page of the "Principles of Geology?"' And he adds, "I think that he who writes fairly the history of his own progress in geological thought will not easily be able to separate his debt to Hutton from his obligations to Lyell." This cordial testimony of a fellow-laborer in the cause of scientific enlightenment exactly indicates Sir Charles Lyell's place in the history of that task. He was a man of singularly open mind, one of those who stand above their cotemporaries and hail the dawn of new truths upon the world. His own works mark the progress of his own as well as of the public opinion on the great problems raised by scientific discovery, and he remained to the end of his life always ready for the reception of new facts, and for the corresponding modifications of opinion.

"Sir Charles Lyell had traveled and seen much. Thus in early manhood he explored many parts of Norway, Sweden, Belgium, Switzerland, Germany, and Spain, including the volcanic regions of Catalonia. In 1836 he visited the Danish Islands of Seeland and Monen, to examine their Cretaceous and Tertiary strata. In 1841 he was induced to cross the Atlantic, partly in order to deliver a course of lectures on his favorite science at Boston, and partly in order to make observations on the structure and formation of the Transatlantic Continent. He remained in the United States for a year, traveling over the Northern and Central States, and extending his journey as far southward as Carolina, and northward to Canada and Nova Scotia, his explorations ranging from the basin of the St. Lawrence to the mouths of the Mississippi. On returning from this journey, he published his "Travels in North America," a work of considerable interest to other persons besides geologists, and showing that he could extend his observations to the stratification of society around him as well as that of the earth beneath his feet. He paid a second visit to America in 1845, when he closely examined the geological formation of the Southern States and the coasts that border on the Atlantic and the Gulf of Mexico, and more especially the great sunken area of New Madrid, which had been devastated by an earthquake 30 or 40 years previously. Upon reaching England, he published his "Second Visit to the United States," a companion to his former work. For his other scientific papers we must refer our readers to the "Proceedings" of the Geological Society, 1846--9, and its "Transactions."

"Late in life, about ten or twelve years ago, Sir Charles Lyell published another very important work, on "The Antiquity of Man," summarizing and discussing all the important facts accumulated up to that time in favor of the high antiquity of the human race, viewed from the standpoints of the archæologist, the geologist, and the philologist.

"Numerous honors were conferred on Lyell in recognition of his services to science. As far back as 1836 he was elected to the Presidential Chair of the Geological Society, to which he was re-elected in 1850. He received from Her Majesty the honor of knighthood in 1848, and in 1855 the honorary degree of D. C. L., of the University of Oxford was conferred upon him. He had been for many years a Fellow of the Royal Society, and in 1833 received one of the Royal Society's Gold Medals for his "Principles of Geology." In 1858 the Royal Society conferred upon him the highest honor at their disposal—the Copley Medal; and in 1864--5 he filled the Presidential Chair of the British Association for the Advancement of Science. He received the Wollaston Gold Medal from the Geological Society of London in 1865 (his continued official connection with which had precluded his receiving it earlier). He was raised in 1864, on the recommendation of the then Prime Minister, Lord Palmerston, to a Baronetcy, which now becomes extinct by his decease. He was a Deputy-Lieutenant for his native county of Forfarshire.

"Sir Charles Lyell has been so long and so honorably known among the scientific teachers of the time, that though he had arrived at his seventy-eighth year, and the period of his chief intellectual and physical activity had long passed away, probably even the younger men of the present generation will feel that science is poorer by his loss.

"At the meeting of the Geological Society of London, held in the Society's room, Burlington House, Picadilly, on Wednesday last (February 24th), the President, John Evans, Esq., F. R. S., before commencing the business of the meeting, alluded to the great loss which all present had sustained. He little expected, when speaking on the last occasion, at the Anniversary Meeting, of the services which Sir Charles Lyell had rendered to science for the previous fifty years, that he should have on the present occasion to announce and lament his irreparable loss. Sir Charles Lyell had been a true philosopher and a sincere friend. He had lived to see the extension of science which he had so eagerly desired realized. In future times, wherever the name of Lyell shall be known, it will be as that of the greatest, the most philosophical, the most enlightened geologist of Great Britain or Europe.

"In accordance with the wish of the Council of the Royal Society, Sir Charles Lyell will rest beside his old friend and fellow-laborer in science, Sir John Herschel, in Westminster Abbey."

We add the following appreciative remarks from Nature of March 4th.

"Lyell's claim of fame lies in this, that he organized the whole method of inquiry into the history of the formation of the crust of the earth, and established on a sound footing the true principles of geological science; his theory being that, by the uniform action of forces such as are now in operation, the visible crust of the earth has been evolved from previous states.

"Lyell was not only a keen investigator of natural phenomena; he was also a shrewd observer of human nature, and his four interesting volumes of travel in America are full of clever criticism and sagacious forecasts. His mind, always fresh and open to new impressions, by sympathy drew towards it and quickened the enthusiasm of all who studied nature, Had he done nothing himself, he would have helped science on by the warmth with which he hailed each new discovery. How many a young geologist has been braced up for new efforts by the encouraging words he heard from Sir Charles, and how many a one has felt exaggeration checked and the faculty of seeing things as they are strengthened by a conversation with that keen sifter of the true from the false!

"Though by nature most sociable and genial, yet Sir Charles often withdrew from society where the object of his life, the pursuit of science, was not promoted; but when anything interesting turned up he always tried to share his pleasure with all around. Many of us will remember the cheerful and hearty "Look here"—"Have you shown it to so and so?"—"Capital, capital."

"The little wayside flower, and, from early happy associations, still more, the passing butterfly, for the moment seemed to engross his every thought. But the grandeur of the sea impressed him most; he never tired of wandering along the shore, now speaking of the great problems of earth's history, now of the little weed the wave left at his feet. His mind was like the lens that gathers the great sun into a speck and also magnifies the little grain he could not see before. He loved all nature, great and small.

"Much we owe to Leonard Horner, himself a good geologist, for having inspired the young Charles Lyell. In after years, when already well known, Charles Lyell chose as his wife the eldest daughter of his teacher and friend. Many have felt the charm of her presence—many have felt the influence of the soul that shone out in her face; but few know how much science directly owes to her. As the companion of his life, sharing his labor, thinking his success her own, Sir Charles had an accomplished linguist who braved with him the dangers and difficulties of travel, no matter how rough; the ever-ready prompter when memory failed, the constant adviser in all cases of difficulty. Had she not been part of him she would herself have been better known to fame. The word of encouragement that he wished to give lost none of its warmth when conveyed by her; the welcome to fellow-workers of foreign lands had a grace added when offered through her. She was taken from him when the long shadows began to cross his path; but it was not then he needed her most. When in the vigor of unimpaired strength he struggeled amongst the foremost in the fight for truth, then she stood by and handed him his spear or threw forward his shield. He had not her hand to smooth his pillow at the last, but the loving wife was spared the pain of seeing him die.

"It doubtless occurred to many a one among the crowd who saw him laid to rest among the great in thought and action, that he might have been eminent in many a line beside that he chose.

"His was a well-balanced judicial mind, which weighed carefully all brought before it. A large type of intellect—too rare not to be missed. But it was well that circumstances did not combine to keep the young laird on his paternal lands among the hills of Forfarshire: it was well for science that he was induced to prefer the quieter study of nature to the subtle bandying of words or excitement of forensic strife. Failing health had for some time removed him from debates. Still to the last his interest in all that was going on in the scientific world never failed, and nothing pleased him more than an account of the last discussion at the Geological Society, or of any new work done. As a man of science his place cannot be easily filled; while many have lost a kind, good friend."

The number of *Nature* for August 26, contains an excellent portrait of Sir Charles Lyell, accompanying a biographical notice by Prof. Giekie.*

A list of Lyell's memoirs to the close of 1863 will be found in the Royal Society Catalogue, numbering, with his elaborate works, no less than seventy-one separate communications in his own name, and five more in connection with others.

Descriptions of Lepidopterous Larvæ, with Remarks on Their Habits and Affinities. Read before the Cincinnati Society of Natural History, at the regular meeting, Oct. 5, 1875. By A. G. Wetherby

It is a fact well known to the naturalist, that the early stages, in the life of all objects of natural history, have been much neglected until within recent years. This is a fact the more to be regretted, when we consider the important part that the morphology and embryology of species now has, in determining their proper places in the great system of nature. Although much more has been done in this regard, in entomology, than in the other branches of zoological science, yet, much more remains to be done; not only in bringing to light facts in regard to new species, but new facts in reference to those already known. Thousands of species have been described from the imago, of which all the previous stages are unknown, and many of the descriptions given are from single specimens, and full of inaccuracies. Especially is this the case in reference to larvæ. The descriptions of the larvæ of species of *Sphingidæ*, which I have lately had occasion to examine, will frequently apply as well to one species as another. Indeed, Sphinx proper, *Deilephila*, *Smerinthus* and *Sesia*, are indiscriminately jumbled together, without pointing out the plain differences which separate them. For purposes of identification, descriptions should be as full as possible; and when it is remembered, that the colors of caterpillars differ in the same stages

*Artist's proofs of this portrait (engraved on steel by C. H. Jeens) may be had at the office of *Nature*, 29 Bedford Street, Strand, London, W. C. Price 5s. each.

of the same brood, and that each moult of the larvæ adds or subtracts essential features, the importance of correctly describing the adult caterpillar cannot be overestimated. If some of the larvæ, forming the subject of this paper, have been described more fully, I shall be only too glad to know it. As what I have written, has been from actual study of the living specimens, bred by myself, those descriptions, which are, correct, must agree with mine; and those less correct will be rendered plainer to the student by what is here offered. It may not be out of place to add, that my experience, in rearing lepidopterous larvæ, extends over a period of five years, during which time many scores of specimens have been bred, of many species, giving the fullest opportunities for their study.

As many of the larvæ herein described are, as yet, unknown to me in the perfect state or imago, I have numbered these descriptions, and their future determination will depend upon my success with pupæ now in my possession, or upon knowledge already in possession of naturalists. The species herein described have been reared during the present season, some of which have reached the pupa state, while others are still feeding in the cages.

Limacodes And Its Allies.

This anomalous group, which derives its name from the slug-like form of the larvæ, has its distinguishing characteristics as follows: Larvæ oval or oblong, flattened beneath, oval, rounded, or flattened above, (or with two of these peculiarities united), flattened and keeled at the sides, and frequently ornamented with rows of fleshy spines and tubercles, inserted at the ridge of the keels. These spines and tubercles, in all the species bearing them that have come under my observation, are densely spinulose, and often highly colored. The head is covered by a remarkable development of the anterior margin of the second segment, which, for convenience, I shall call the *hood*, and which is brought down over the head and mouth parts of the insect when feeding, to the margin of the leaf, and folded over the edge to the side opposite that upon which the insect rests, concealing the head and mouth parts entirely. The thoracic legs are well developed, though difficult to see, as they are withdrawn into the fleshy envelope which surrounds them. If, however, the insect be placed upon its back, in the struggle to regain its natural position, they will be thrust out, and will be seen as small, white, sharp points. I have been unable to see that they are of any use to the insect as organs of locomotion, as, during that process, they are withdrawn, and not brought in contact with the surface passed over. I have been unable to detect upon them the spinules found upon the thoracic legs of many other caterpillars.

The pro-legs are wanting, but in their stead is a curious, sac-like development of the under surface of the body, which can be protruded at points where the pro-legs would be situated if present, and by means of which, combined with an undulatory motion of the whole ventral region, but notably so of the posterior two thirds, the insect glides gracefully along any smooth body. Like the slug, their progress upon dry and dusty surfaces is very slow and soon stops. No slime or mucus is exuded. I have bred the larvæ of eight species of this group, during the present season, and a remark as to how it was done may not be out of place. We have among lepidopterous larvæ certain ones which are known as "general feeders;" that is, they will eat the foliage of a great many different plants. Notable among these is the whole family of the Arctians, and scarcely less general, in this respect, is the group under consideration. I have found the larvæ of *Empretia stimulea* (Clemens) on the papaw, raspberry, cherry, basswood, and Indian corn, during the present season. In confinement, it will eat one of these plants, one day, and an entirely different one on the next. If not disturbed, a leaf, which they once begin to eat, will be entirely devoured, without the insect's leaving it, except the basal fourth of the midrib. They devour the leaf backwards and forwards, from side to side, at right angles to the axis, moving backward as they eat, until the leaf is consumed, when they seek the nearest one, creep to the apex, lap the "hood" over in the usual manner, and begin anew. They are very voracious, and never seem to rest between meals like other caterpillars, but will always be seen gnawing the leaf greedily, so that they devour as much food as other caterpillars many times their size.

I fed my specimens, under common tumblers, putting them on the under side of the leaf, which is their natural position, and then slid the leaves under the glass, one edge of which was kept slightly raised for sake of ventilation. When full fed they leave the food plant, and soon after eject a few drops of a viscid, watery looking fluid and shrink to two thirds their previous size. When these changes were observed, I placed them in a box, with bits of paper, or a few dry leaves, and the cocoon, which is dense, brown and oval, was finished in a very few hours. Indeed, in more than one case, an hour and a half or two hours only was necessary, for the insect to finish its cocoon, so far as to be completely hidden. I am positive as to the identity of but one of the species of which the descriptions follow. The cocoons of the others are now in my possession, in various numbers, except the second and third, the caterpillars of which escaped after they had been brought nearly to maturity.

Number one. *Limacodes*——? Larvæ flattened above and at the sides, with dorsal and lateral longitudinal keels, ornamented with rows of densely spinulose fleshy tubercles, those on the dorsal keels being much the longer, and of these, two thoracic pairs on the third and fourth segments, and the pair on the eleventh segment are much the longest. Color dark grayish green, with rows of lighter silvery gray spots, small, and nearly round. The same color extends to the tips of the tubercles, and over the whole dorsal and lateral surfaces, giving the larvæ the appearance, at a short distance, of a bit of gray bark or lichen. Under surface light dirty green. Thoracic legs white and minute. Head and mouth parts dark brown, and concealed beneath the grayish hood. Length $\frac{3}{4}$ inch: width, at sixth segment, $\frac{3}{8}$ inch, exclusive of the spines. September 10, 1875 *Planus occidentalis.* S. L. Hewitt, Esq., one specimen.

Remarks. This interesting larvæ was brought me on the date above mentioned, and when taken from the box, in which it had been placed, was still feeding. When placed under the glass, it ate the maple and cherry as well as the sycamore. It is the thinnest species, from the dorsal to the ventral surface, of any that I have bred. It affords the best case of protective mimicry, of any larvæ I have seen, except *Catocola* and some of the *Phalænidæ*, being exactly the color of the grayish green bark of the tree on which it feeds. The cocoon, which was spun between two leaves, was finished, to all outward appearance in half a day. It is small, oval, dense, slightly silky on the outside, and darker colored than those of its allies.

The striking resemblance of the insect to a bit of grayish bark or lichen, and the rows of lighter spots, will enable any one to recognize it at once. If undescribed, it may be called *Limacodes argentatus.*

Number Two. *Limacodes*——? Larvæ oval, flattened above, slightly keeled and flattened at the lateral surfaces.

Color light pea green, with obscure lighter spots irregularly scattered over the dorsal and lateral areas. Dorsal surface, as seen from above, nearly oval, more pointed behind. Keels without spines or ornamentation. Under surface light yellowish green, thoracic legs white. Head and mouth parts light brown, concealed under the hood. Length, $\frac{5}{8}$ inch: width, at sixth segment, $\frac{3}{8}$ inch. Sept. 5, 1875. Cherry, one specimen.

Remarks. I found this interesting larva, at the date above mentioned, on the common cherry. It was full grown, and escaped on the day but one following, after having commenced its cocoon. It was a soft, pulpy looking caterpillar, with a half transparent appearance, very sluggish in its motions, and would have been taken for anything else in the world as soon as for the larva of a lepidopterous insect. A single specimen only has been observed.

Number three. *Limacodes*——? Larva oblong oval, flattened above and at the sides, with dorsal and lateral longitudinal keels, ornamented with spinulose and fleshy tubercles and spines, the meta-thoracic pairs, and the last pair on the dorsal keels being the longer. Color, yellowish green, sprinkled with brown and golden spots. On the back are two pairs of conspicuous, rectangular, reddish spots, which are symmetrically arranged each side of the central line. Tips of the long tubercles lighter than the base.

Under surface very light yellowish green. Thoracic legs white and minute. Head and mouth parts brown, and concealed under the hood. Sept. 10 and 24, 1875. *Acer saccharinum.* S. L. Hewitt, Esq., two specimens.

Remarks. This interesting and beautiful species was brought me by Mr. Hewitt at the same time as number one, and was found by him on the same tree, *Planus occidentalis.* Subsequently, on the 24th, ult., I found a specimen on the sugar maple, (*Acer saccharinum.*) It is nearest allied in shape, position of the keels and tubercles, and in size and comparative flatness of the body, to number one herein described. The general appearance is that of a mottled, golden green, with the four rectangular spots of red very prominent. These features will enable any one taking the larvæ to recognize it readily.

These specimens, after having been fully fed, escaped when about to make the cocoon, so that I am unable to describe it, and shall not obtain the perfect insect from which to determine the species.

Number four. *Limacodes*——? Upper and lateral surfaces flat, widest in the center, and drawn together in a point at the posterior extremity of the insect. Upper surface arched, highest in the center, lowest at the hood, and attenuated at the caudal extremity, ending in a minute brown point, slightly curved upwards. Lateral boundaries arched above, nearly straight below, but slightly curved upwards posteriorly. Lateral surfaces joining the dorsal at right angles, making a sharp ridge or keel, extending the entire length of the insect. Larva without spines or tubercles. Color grass green above and at the sides, lighter beneath. Along the dorsal ridges are a few obscure markings. indefinite, except two light spots narrowly edged with brown near the tail, and a few small, blackish dots, on the lateral surface, just beneath the keel or ridge. Stigmata very small, and arranged in a straight line, two thirds of the way down the lateral surfaces. Thoracic legs exceedingly slender and minute, white, and concealed by the fleshy envelope. Mouth parts chesnut brown; head light green, entirely concealed by the hood. Length $\frac{5}{8}$, breadth of under part $\frac{3}{8}$, height at middle, $\frac{5}{16}$ inch. Sept. 20, 1873, and Sept. 24, 1875. Burr oak and Tartarean honeysuckle. Master Ernest Baker. Two specimens.

Remarks. This is by far the most remarkable insect of the group that I have yet seen, not only on account of its odd and nondescript form, but on account of the habit it has of remaining fixed to one leaf, until it is devoured, down to the very least amount of space upon which the insect can make its footing secure. When full fed, and before leaving the food-plant, no segments are visible, the caterpillar somewhat resembling one of the large, triangular leaf-hoppers, *Psyllidæ.* When turned upon its back, the boundaries of the lower surface, or edges of the lateral surfaces, give the insect the appearance of being enclosed in a shell.

When, however, the fluid is ejected, previous to the formation of the cocoon, and the larva shrinks as before mentioned, the segments become distinctly visible. The specimen captured this season, spun its cocoon Oct. 2d, 1875. The cocoon is not so dense as that of the other species described, and is of a lighter color. The insect must be sought on the under side of the leaf, and is evidently very rare, but two specimens having come under my notice in three years.

Number five. Larva of *Callochlora chloris*, H-Schaeffer. Larva flattened above and at the sides, with two dorsal and two lateral keels, ornamented with densly spinulated tubercles, there being nine on each lateral keel, and six on each dorsal keel. Of the latter, the front pair is shorter than the others. Between the dorsal keels are four, narrow, purple, longitudinal lines, between which are three narrow white lines, the latter sometimes tinted slightly with pink. Similar lines extend along the lateral surfaces, between the dorsal and lateral keels, and below the latter. Head and mouth parts chestnut brown, concealed beneath the hood, but not so entirely as in the other species of this genus, except when feeding. Thoracic legs white and minute. General colors rose and orange, the middle third of the dorsal keels and their spines being brilliant rose color, or light crimson, and the rest bright orange. A variety, or a species so closely allied, as to show no difference but in color, has the spines lemon yellow, and the general surface lighter than the specimens here described. Food-plants, Tartarean honeysuckle, pear, oak, cherry &c. From September 3d, to October. Many specimens.

Remarks. This beautiful insect, by far the most common of the family, is a conspicuous object, from the contrast of its lively colors with the dense green of the foliage upon which it feeds. It is the only member of the family upon which I have observed any parasitic attacks. In a few cases, I have found the eggs of a species of ichneumon on the dorsal surface of the specimens, but, having removed them, I was unable to find that they had perforated the larvæ with the exception of a single example, which refused food and died. These larvæ are easily reared, though a few will die during the moulting season. It is difficult to reconcile the theory of protective mimicry, with cases such as this. The larva is so conspicuous, both from its magnificent colors, and from their contrast with the dark green of the leaves, that the keen eye of an enemy would easily detect it. But its resemblance to flowers in the foliage may serve the theorists for an argument. The imago is in my possession, from the broods of previous years, so that I am able so identify the species beyond a doubt.

Number six. Larva of *Empretia stimulea* Clemens. Larva convex above and at the sides as far as the lateral keels; below this flattened, with a narower keel extending around the posterior extremity. Thoracic segments expanding suddenly from the head backward, and bearing upon the fourth a pair of densely spinulose tubercles, between which is a light green oval spot. A similar pair of tubercles ornaments the tenth segment, below and behind which, are two light yellow irregularly oval spots. Color of head and thoracic segments chocolate brown, as are the metathoracic tubercles, and the pair on the tenth segment, together with an irregular space at their base. Between the two pairs of tubercles, and extending down the sides to the lateral keel, the color is light green, bordered with white, except a large, oval spot, in the center of the dorsal surface, which is chocolate brown, ringed with white. The green space hardly reaches the base of the thoracic spines, but extends laterally below and back of the pair on the tenth segment, terminating on each side with a velvety tuft of brown hairs, which are separated from a pair of similar tufts, close together on the posterior center of the keel, by two short, densely spinulose tubercles. Lateral keels ornamented with six tufts of lighter, stiff hairs, on each side. Thoracic segments bearing four large tubercles and four small ones, in front of, and below the large pair. Under surface, dirty white or brown. Head and mouth parts brown, and concealed under an enormous hood. Thoracic legs white and minute. Length, $\frac{9}{16}$ inch. Breadth at fourth segment, $\frac{3}{8}$ inch exclusive of tubercles. Sept 2, to Oct. 1, 1875. Many specimens. General feeder.

Remarks. This beautiful insect, of which I have reared many specimens, seems to partake of the characters which Dr. Packard gives both to *Euclea Monitor* Packard, and *Empretia stimulea* Clemens.

It is not so common a species as number five, but occurs in limited numbers every season. The spines sting severely. The insect is easily reared, and spins a dense cocoon, surrounded by a more open envelope, as stated by Packard. This species will readily be recognized by the green saddle-like marking of the dorsal surface, with the oval spot in the center, as well as by the curious development of the thoracic segments. Altogether, it is one of the most grotesque and beautiful objects among lepidopterous larvæ.

Number seven. *Limacodes*—? Larva oblong oval, slightly attenuated posteriorly. Dorsal surface flattened, highest in front. Dorsal keels ornamented with eight pairs of rose-colored spiny tubercles, of which the eighth pair is much longer than the others, as well as lighter in color. Dorsal surface beautifully clouded with five oval spots, of a chocolate brown color, surrounded by a narrow rose-colored band, the third from the front being the largest, and extending over the dorsal keels slightly below the spines. First three spots separated from the last two by a slight, yellow, transverse space. The whole upper surface, between the oval spots and around their ends, is light, yellowish green. Lateral surfaces pea green, bordered above by a yellowish green line below the dorsal keels. Under surface light dirty green. Head and mouth parts brown, and concealed under the hood except when crawling. The second and third thoracic segments are then seen to be light pea green. Thoracic legs white and very minute. Thoracic segments bearing a few, scattering, whitish hairs. Length, when extended, $\frac{3}{8}$ inch. Breadth, at sixth segment, $\frac{3}{16}$ inch. Oct. 8, 1875. *Acer saccharinum*. One specimen.

Remarks. This extremely elegant little species, so different from any of its allies, was found on the under side of the leaf on the date above mentioned. It may be recognized very readily, as the beautiful coloring of the dorsal surface, the row of chocolate brown spots, surrounded by the rose-colored band, and the beautiful golden green of the remaining space, sufficiently point it out as distinct. As the larva is yet feeding, I am unable to describe the cocoon. This is much the smallest species I have ever seen, and by far the most active. If undescribed, it may by called *L? nebulosus*.

Number eight, *Limacodes*—? Larva oval-quadrate, with the dorsal and lateral surfaces flattened, and bearing, attached to the lateral margins of the dorsal surface, nine pairs of flat, fleshy appendages, clothed with stiff, bristly hairs, light brown on the upper surface, and *dark velvet brown beneath*. Of these appendages the third, fifth and seventh pairs project beyond the others, at least two-thirds their length. Of the remaining pairs, the second and eighth are the longest, and the first and ninth the shortest. The longer appendages have the hairs parted down the middle, those on the anterior half pointing to the head, and those on the posterior half pointing to the tail. The hairs on the short appendages are not so parted. At the base of each appendage, except those of the ninth pair, is a tuft of hairs so arranged as to point in all directions from the center of the tuft, and leave a middle, longitudinal groove, extending the entire length of the dorsal surface. The third and fifth pairs of appendages are so twisted, as to exhibit their under surfaces at the outer third, and to make the tips point upward and forward.

The seventh pair is not twisted, and points obliquely backward, extending one half its length beyond the caudal extremity of the insect. Lateral surfaces arched above, straight beneath, with a row of light brown tufts of hair above each spiracle. Under surface and lateral surfaces below the stigmata orange yellow, under surface darker at the lateral margins. Head and mouth parts jet black and shining, and entirely concealed under the enormous hood, and this under the first and second pairs of appendages. Length, on dorsal surface $\frac{9}{10}$ inch. Breadth, exclusive of appendages, $\frac{4}{10}$ inch. Oct. 9, 1874. *Ulmus americanus.* Master Ernest Baker. One specimen.

REMARKS. This remarkable insect bears resemblance to *L. hyalinus*, Walsh, and *L. tetradactylus* of the same author, given in Proceedings Boston Society Natural History, Vol. IX. Feb. 1864. While it has characters in common with these, as given in the paper above alluded to, it is double the size of the first, and much larger than the second. The tufts of radiating hairs, forming two longitudinal rows along the dorsal surface, are a notable feature, and could not have escaped the eye of so acute an observer as Mr. Walsh. He does not mention the dark, velvet brown, under surface of the appendages, which is a very striking feature. In color, and in many other respects, it accords well with this description of *L. hyalinus*, and in size with *L. tetradactylus*. The larva is sluggish, and exceptionally voracious. If undescribed, it may be called *L. nondescriptus*.

Results of Investigations of Indian Mounds.

BY JAS. R. PAGE.

[From Trans. St. Louis Acad. Science Vol. 3 page 226.]

In March, 1873, I investigated several "mounds" in Washington and Issaquena counties in the State of Mississippi. Throughout the valley of the Mississippi a very large number of mounds exist, and are especially numerous in the river counties. I have frequently observed these mounds in Bolivar, Coahoma, Issaquena, and Washington, but my examinations have been confined to a very few, and the data obtained will not admit of any generalization; I will therefore confine myself to the facts obtained by the investigations.

In my explorations I observed no works which might be strictly denominated enclosures. One very large mound examined in Washington County was about 80 feet in diameter and 40 feet high, in the shape of a truncated cone. The results of the investigation led me to conclude that this had been a mound of *observation*. On opening it no relics were discovered; it was entirely composed of the soil of the country (denominated "buckshot land"); it is built on the old bank of the Mississippi river, and crowns a conspicuous point which overlooks the surrounding country;—there are no other mounds in the immediate neighborhood.

The second mound examined contained a large number of flint (properly "chert") arrow-heads and hatchets; this mound was about 2 feet high and some 15 or 20 feet in diameter. No doubt at one time it was higher, but, being situated in the middle of a field which has been under cultivation for forty years, it has been cut down by the plow. In the neighborhood numerous arrow-heads lie embeded in the soil and are turned up every spring; no doubt they all existed at one time in the mound and have been plowed out.

About 100 yards distant I opened a third mound, with much more satisfactory and interesting results. This mound, though only 11 feet high, is the most prominent piece of land for miles; it stands in the middle of a cultivated field, and from the top one can see over the open ground for a great distance. This mound in general appearance shows great resemblance to the other mounds in that region, and, though the mounds differ in height and diameter, they are nearly all of a flat turncated-cone shape. This mound under discussion was 11 feet high and 30 feet in diameter at the base. The soil composing the mound is identical with that of the country; this soil is principally a clay mixed with a little sand. (See "Silt Analysis of Soils of Mississippi," by E. W. Hilgard, in American Journal of Science and Art.) The mound was formerly covered by a heavy growth of timber, but is now nearly bare, only one tree standing, a very large white oak (*Q. alba, L.*), 36 inches in diameter; a few steps distant, and near the centre of the top surface of the cone, is the trunk of another oak, 30 inches in diameter.

I commenced investigation by driving an open tunnel, from three different points, on a level with the base towards the centre; after excavating 8 or 10 feet a skull was discovered, but in such a decayed condition that it immediately crumbled to pieces. A few minutes later the workmen in the other two ditches made several similar discoveries. We now became more careful, and by digging around the skull we were able to procure it intact by removing a considerable amount of soil.

The skulls were in a very poor state of preservation—the gelatinous matter had been entirely dissolved away, and the earthy material very much resembled a spungy mass saturated with water, being so soft that water could be pressed out by a very slight force; the bony structure was very fragile, but on drying became quite hard and brittle.

The soil contained a great deal of moisture, being perfectly saturated from two feet below the surface to the base of the mound, and, as the soil was usually in that condition, it was very unfavorable to the preservation of the remains. In one of the better preserved specimens I observed a characteristic which Foster points out in his "Prehistoric Races of the United States"—the tendency at the union between the parietal and squamous bones towards the straight line. In nearly all of the specimens, although the skulls were in a very decayed condition, the perfect form remained; the nasal bones stood out prominently, and the large massive jaw-bones were filled with worn but well preserved teeth; except portions of the upper jaw-bone, none of the facial bones were wanting. From the size of the skulls, I judge the twelve skeletons exhumed were all adults. Many of the other bones of the skeletons were in excellent preservation, as the femurs, tibiæ, and tarsi. As these bones were in a horizontal position and the crania vertical, I have no hesitation in asserting they were seated in a circle, and in a sitting posture faced the centre. From the slight examination given to the skulls during this disinterment. I judged that in brain volume they were not greatly inferior to the Caucasian; but judging from the narrow forehead and the receding frontal bone, and the development of the posterior lobes, the latter must have been the seat of the greater part of the brain. The original contents of the crania had been entirely removed and replaced by soil; this soil dried very rapidly, and in contracting caused the skulls to break to pieces. I was very careful in packing these specimens, but in transporting them nearly a thousand miles by river to St. Louis they became very much injured, some of the skulls being completely destroyed and most of them entirely lost.

I noticed that several of the tibiæ were very much flattened, and supposed it must have been unnatural and occasioned by the pressure from the weight of the overlying soil; until I read H. Gillman's report upon "Indian Mounds in Michigan" in the American Journal of Science and Art, January number, 1874, in which he says, "And I here repeat the interesting fact that all the tibiæ unearthed invariably exhibited the compression or flattened characterizing platycnemic men.

Directly in front of the mouth of each skeleton were placed from two to three vessels of pottery, beautifully ornamented with etchings and tracings, and in one or two specimens figure decorations were attempted. If these vessels were filled on their interment, their contents had long been removed and afterwards replaced by soil. It they originally contained food, all traces of the absence of such could be easily accounted for, as the mound was occupied by numerous ant colonies and other insects; or the contents might have been removed, and then replaced with soil by the water which after every rain percolated the mound. Thinking if the vessels had been filled with food, and if birds or fish had been an article of diet, most probably bones would remain, I subjected the contents to analysis, but under a 400 power microscope no trace of organic remains was to be seen.

Baldwin asks, "What but time could have caused these skeletons to dissolve and become as dust, as all the circumstances attending their burial were unusually favorable to their preservation? The earth around them has been invariably found to be wonderfully compact and dry." The condition of the bones cannot always be used as an accurate measurment of time, as here were remains found surrounded by very unfavorable circumstances for their preservation.

Squier and Davis claim to have found a skull belonging incontestably to the Mound Builders taken from a mound situated in the Scioto Valley, four miles below Chilicothe; but Foster says (p. 291), "Any comparative anatomist on referring to their plate will instantly recognize it as of the Indian type." Foster says that our knowledge of the Mound Builders' crania is exceedingly scant, as we have found but few specimens which were incontestibly of that race. In regard to the bones I disinterred there can be no question; the surrounding circumstances prove them to belong to them beyond a doubt; the positions of the skeletons, and pottery, and other contents of the mound, clearly prove they could belong to no other race.

The work upon the various vessels made of pottery would indicate that the Mound Builders had attained a high degree of skill in the plastic art, and this race must have been far in advance of those living in the Stone and even Bronze Age of Europe, as Sir John Lubbock says that "few of the British sepulchral urns belonging to the ante-Roman times have upon them any curved lines. Representations of animals and plants are also wanting. They are even absent from all articles belonging to the Bronze Age in Switzerland, and I might also say in Western Europe generally, while ornaments of curved and spiral lines are eminently characteristic of this period. The ornamental ideas of the Stone Age, on the other hand, are confined, so far as we know, to compositions of straight lines, and the idea of a curved line scarcely seems to have occurred to them. The most elegant ornaments on their vases are impressions made by the fingernail, or by a cord wound around the soft clay."—(*Prehistoric Times*, p. 257,)

The Mound Builders were not content with straight lines: here are over 20 specimens taken from this mound, and you can see how beautifully the surfaces were ornamented with fret-work and various figures; and here is a kettle-like vessel having for one side the profile of a human being. One of the specimens was undoubtedly a water jug, and being unglazed water could readily permeate the clayey material, and, rapidly evaporating in hot weather, would create a lower temperature than the surrounding air and then impart its temperature to the enclosed water, and by this device furnish a cool beverage for summer.

Besides the pottery, the mound contained other interesting relics, one of which was an article made of magnesian limestone, round in shape, being two inches in diameter and a quarter of an inch thick, and discoidal on both sides. This is a characteristic implement, and frequently found in sepulchral mounds. Foster quotes a number of speculations indulged in as to the uses of this discoidal stone—among them the suggestion of Schoolcraft, that they were used as quoits. The little notches in the sides of the one I have here would give color to the supposition; and they were evidently made by striking against some hard substance, for in places the stone was worn very smooth, as through much handling.

Another implement was made of a very hard sandstone, almost quartzite; its shape was a flat quadrilateral figure, 6 inches long by 4 wide, and 2 in thickness.

Among the other interesting relics was a pipe, from which it seems the Mound Builders were not unaware of the narcotic properties of tobacco. The pipe was very plain, having not a single line for ornament. During the disinterment a small fracture revealed a fresh surface showing that the pipe was manufactured from fire-clay: it had been burned very hard, and from its appearance I judged it had seen a great deal of service.

In this mound I discovered no metalic remains, though I was informed by a gentleman who had opened several that he had found implements of copper and plates of mica, with fragments of obsidian. These facts would indicate that they enjoyed commercial advantages to a very high dergee, as I am acquainted with no point where obsidian could have been procured nearer than Mexico—the mica most probably from North Carolina, it being the nearest point where that mineral occurs. As the Mound Builders must have been ignorant of the art of smelting, this copper must have been procurred in a native state from the mines of Lake Superior, and that they did work these mines seems no longer a question of doubt. Professor Pumpelly, our late State Geologist, informed me he had seen marks of mining there of great antiquity, which must have been the work of the Mound Builders.

We should not be too hasty in drawing our conclusions, as relics sometimes found under circumstances which would indicate their Mound Builders origin, are afterwards proved to belong to another race. Prof. G. C. Forshey, in "Ancient Monuments," says "Mounds! mounds without number * * * The first of these groups is some fifty miles above Vicksburg, on the west bank of the Mississippi, two miles back, on the estate of Dr. Keene Richards, called Transylvania. The temple, which is the central figure of twelve mounds, looms up grandly from the level of the alluvial plain. Arrow-heads and pottery have always been abundantly found on these mounds. *One of them is used as a cemetery for the colored population of the plantation.*" (The italics are mine.) I wish to draw attention to the fact that too great care cannot be exercised in these investigations as the negroes are usually burried in coffins of light wood, which in that damp soil decay in a very few years; and as they are usually interred with their necklaces of beads and other trinkets, these relics found in the mounds might lead to great confusion in assigning to them their proper origin. It is not an unusual case in the South to use the mounds as cemeteries for the negroes. I have seen several used for that purpose.

I have been in communication with Mr. Anderson, of Centreville, Ohio, who examined a large number of mounds throughout the Mississippi Valley to Mexico, and who visited us on the plantation in Mississippi several years ago, and during his stay examined a number of mounds in the immediate vicinity of my explorations, and I will conclude my remarks by reading a few extracts from his letter:

"A desire to send you photographic representations of the articles found in my hurried explorations of the Issaquena Mounds, is I hope sufficient apology for the delay in answering your favor of the 21st ult.

"The result of the examinations were to me a great and agreeable surprise. I knew not what to expect beyond a few pieces of mica, some broken earthenware, and perhaps a specimen or two of obsidian, and therefore felt unusual pleasure in bringing to light a rich and remarkable collection of vases, urns and bowls of archæological pottery, and varied and various implements of stone, which you will find figured in the accompanying charts. With one exception, the vessels are all of the same material as those usually found in mound excavations, well-worked clay intermixed with broken shells or other calcareous matter. The exception is a little pot-hooked vessel with ears for hook suspension, which is of a darker color and apparently of a firmer material, though much injured when exhumed.

"I will now give, as you request, some account of the labor and discovery. On the 22d of February, 1871, I commenced opening the mound by trenching on the level from the west. The first bones disturbed were the extremities of three individuals buried standing. The femurs, tibiæ and tarsi were in good preservation, and maintained their vertical positions so perfectly that one of my companions exclaimed, "These fellows must have been buried in a barrel.' The more earthly bones of the dorsal and cervical vertebræ had entirely disappeared. My surmise was that they were the sentinels or outstanding guards, with heads above ground "to watch and ward" over their superiors in the centre. We next reached a large deposit of ashes and burnt earth, the residuum of a sacrificial fire was so intense that not a bone or even tooth was discoverable, over this large bed of undistinguishable rabble, waiting their delivery.

"Approaching the centre of the mound, and about five feet above the level we met with a few pieces of pottery, then a whole specimen, and another and another to the number of twenty-five or thirty. I confess now to having felt an almost childish delight at the discovery. I had broken into the domestic sanctum of a venerable Mound Builder! I had resurected his bones and robbed his ancient pantry! I had scattered his armory and rejoiced! I rejoiced at my folly and my good luck, and why should I not? Messrs. Squier and Davis had said, "It is much to be regretted that none of these remains have been recovered entire in the course of our investigations." Now bear in mind that they had opened scores and scores of mounds; and I now learn from Llewellyn Jewett, in his "Grave Mounds and their Contents" of Great Britain, that it must not be supposed that they, (the urns, &c.) are often found in a perfect state; on the contrary, the urns are usually very much crushed.

"As near central as possible lay the three great men of the nation; around them matters of use and ornament, urns and vases, beads and arrows; adjoining the heads of each, in pairs, a drinking vessel and a food vessel, all once filled, but now alas! skull, urn, and bowl, quite empty, dry, and foodless. Not far off we discovered two skeletons on whose crania the bowls were placed like hamlets. I know not whether this was accident or design; I think the latter. I had no authority to "prophesy on the bones or make them speak; but I felt persuaded that my new-found friends had once been mighty leaders, perhaps glorious heroes, in their days of action.

"In this little collection you will find some points of agreement and some of difference from the contents of other mounds. The cinerary urn on Chart No. 2 is the exact counterpart of those delineated in the work of Llewellyn Jewett, where, as the little common caricature of the human face on the same plate, was perhaps never seen before The celts or wedges have also their concord and discrepance. The three larger are of silicified wood: the grain, bark and knot marks strongly resemble sycamore; some are jasper-colored, others gray and yellow. I think I have never before seen instruments with keener edge or brighter polish.

"I send also for your acceptance and consideration the photographs of two *curved* stones: the one is a copy of the disc obtained for me by my friend Dr. Robinson, of Lake Washington, Miss., and which was taken out of an Issaquena mound; the other photograph is of the world-renowned Toltec Calendar. The first one, with its birds, serpents, and pipe border, was the moving cause of my subsequent investigation in Issaquena. The contemplation of this stone excited in me an archæological interest I had never known before. My memory carried me back to the many hours I had spent under the walls of the Cathedral of Mexico trying to unravel the mystery of that old record of Time. I have fancied a resemblance, but I cannot establish a complete agreement between the two tablets. Here are the eighteen pipes of the border, corresponding to the eighteen months of the year, but the twenty days of the month and the five intercaleries are not to be found. The thirteen hieroglyphical figures and the four zodiacal signs, which as multiples give the forty-two years of the Aztec cycle, are also absent on the Mississippi stone.

Yours very truly,
W. MARSHALL ANDERSON."

The Square Crinoid Column—BY S. A. MILLER.

The square crinoid column has been found at various localities, in the upper part of the Cincinnati Group. It has been found about Lebanon, in Warren county, in Clinton county, and about Versailles, Indiana. Dr. W. H. H. Hunter of Versailles recently found a slab, with several specimens upon it, some of them showing the square column, as it passes into a beautiful round one. The opinion I have formed, from an examination of these specimens is, that the column of the crinoid is round, until it approaches the head, where it changes suddenly to a square column. It is about the size of an average column of the *Heterocrinus simplex*. Generally every fourth plate, in the column, is about twice as thick as either of the three preceding ones; the thicker plates are not, however, of uniform thickness, and it may be that sometimes the third plate or the fifth one is the thickest instead of the fourth. Where the column is round the thicker plates project very slightly, if at all, beyond the thinner ones, but where the column is square the thicker plates project decidedly beyond the thinner ones. Each plate is marked with lines radiating from the central part to the circumference in such manner, that the column shows two serrated edges fitting together between each two plates which makes it peculiarly beautiful under an ordinary magnifier. The round part of the column so far as it is composed of plates with serrated faces, the projecting teeth of one plate fitting into the corresponding notches of those in contact with it above and below, has some resemblance to the columns of *Schizocrinus nodosus* of the Trenton limestone of New York, and *Glyptocrinus ramulosus* of the Trenton limestone of Canada, though easily distinguished from both of them. The square part of the column is unique, and stands alone in form, among all the crinoid columns known to me. The head of the crinoid is wholly unknown and consequently the genus to which it belongs is undetermined. The slab is in the possession of Dr. R. M. Byrnes at the corner of Race and Fifth streets where it may be seen at any time.

This number closes the second year of the "Cincinnati Quarterly Journal of Science," and terminates its existence. We have been induced to cease the publication not only because it is unremunerative, but for the stronger reason, that the Cincinnati Society of Natural History, having a very large membership and considerable money in the treasury, ought to sustain a publication of its own, either in the form of transactions of the Society, or a Journal devoted to Natural History, and our continuance of this Journal will only delay the commencement of such a publication. Indeed, it was never the intention to continue the Journal, beyond the period, when it should become evident, that the Society was able and in duty bound to publish its proceedings, if it aspired beyond the collection and arrangement, merely, of a museum. We think that time has come and feel gratified in being able to state, that some steps have already been taken in that direction, with a prospect of a publication at an early day.

BOOK NOTICES.

Prof. E. T. Cox introduces the Sixth Annual Report of the Geological Survey of Indiana (1874), with the following declaration:

"In a paper which I read at the Indianapolis meeting of the American Association for the advancement of science in 1871, attention was called to the fact that the silurian beds, so well displayed at Cincinnati, were not elevated by a local axis of disturbance, but that the rocks of this famous district simply partook of the general continental fluctuations of level. Neither in Indiana nor in the adjoining State of Ohio, especially in the region around Cincinnati, have I been able to discover any evidence of a local disturbance or axis of uplift. On the contrary, the strata are almost horizontal for many miles, in a westerly course, from Cincinnati. Strata equivalent to these which occupy the tops of the hills at Cincinnati, and 430 feet above the Ohio river, are seen in Jefferson County, Indiana, at about the same level above the stream."

It is remarkable, that the State Geologist of Indiana, after having the advantages afforded by this Journal and the Ohio Geological Survey, should make such a grave mistake. It has been well known for several years past, by every collector of fossils about Cincinnati, who paid the least attention to elevations, that the strata dip in a westerly direction from Cincinnati more than ten feet per mile. The strata, at Cincinnati, bearing *Stellipora antheloidea* and *Orthis sinuata* 360 feet above low water mark of the Ohio, are found at Lawrenceburg about 200 feet above the river. The strata, at the tops of the hills at Cincinnati 450 feet above the Ohio, pass below the bed of Laughery Creek, at the distance of 40 miles west of Cincinnati. The rocks may be traced by their lithological character and shown to have their dip westerly; but their fossil contents make an easy and unerring guide from hill to hill and from valley to valley, and if there is any locality in the western States, where the fossil contents of the rocks have been closely studied and their variable characters at different elevations approximately ascertained, it is in the vicinity in question—Such study and observation, however, have not been, it would seem any part of the labor of the Indiana Geologists—for we find, not only the errors in the foregoing quotation, but a published list of the lower silurian fossils found at Madison, Jefferson County, wherein are placed under the head of "Trilobites" (the first subdivision) the name *Phacops gallicephalus*; under the head of "Orthis" (the 2nd subdivision) such names as *Ambonychia radiata, Avicula insueta, Modiolopsis modiol-ris, Streptelasma corniculum* and *Cyrtoceras lamellatum*; under the head of "Univalves" (the 3d subdivision) such names as *Orthoceras junceum, Chetetes tuberculata, Chetetes ponderosa, Chetetes ponderosa var gracilis and Stenopora fibrosa*; under the head of "Parasitic corals" such names as *Stenopora petropolitana* and *Ortonia minuta*; and under the head of "Encrinites," *Heterocrinus subcrassus* and *Graptolithus mucronatus*. It is quite true, that the State Geologist did not make this catalogue, but somebody should be responsible for its publication, and we presume the author of the paper read before the Indianapolis meeting of the American Association, without much hesitation, assumed the responsibility. It is a pity, however, that such matter should find its way into any State Geological Report this side of Texas, where the Chief Geologist has been informed, that the wooden foundations of school houses petrify in twenty-five years and standing trees are stopped in their growth by petrification, but never could find time to visit the locality.

PALEONTOLOGY OF OHIO VOL. 2—We have received advance sheets of part of this volume. Profs. Hall and Whitfield have made three new genera for fossils found in the Cincinnati Group and fifteen new species. The genus *Schizocrania* includes but one species which has been called heretofore *Crania filosa* or *Trematis filosa*. The genus *Cuneamya* includes two new species; and the new genus *Orthodesma* includes two new species and the two species heretofore called *Orthonota parallela* and *O. contracta*. The new species are as follows: *Lingula*

Covingtonensis, *Lingulella Cincinnatiensis*. (This species has heretofore been called *Lingula quadrata*) *Modiolopsis concentrica*, *Modiolopsis Cincinnatiensis* (This species has heretofore been called *M. anodontoides*) *Sedgwickia? divaricata*, *Cuneamya Miamiensis*, *C. scapha*, *Orthodesma recta*, *O. curvata*, *Orthoceras Duseri*, *O. Carleyi*, *O. turbidum*. *Gomphoceras eos*, *Beyrichia quadrilirata* (which is probably the synonym for *B. regularis*) and *Plumulites Jamesi*.

Prof. H. Alleyne Nicholson has made one new genus for the corals of this Group and described nineteen new species. The new genus *Columnopora* includes but one species. The new species are as follows: *Columnopora cribriformis*, *Chætetes approximatus*, *C. attritus* *C. subpulchellus*, *C. gracilis*, *C. delicatulus*, *C. nodulosus*, *C. Jamesi*, *C. rhombicus*, *C. briareus*, *C. sigillaroides*, *C. discoideus*, *C. clathratulus*, *C. corticans*, *C. Ortoni*, *C. Newberryi*, *C. petechialis*, *Constellaria polystomella* and *Plæophyllum divaricans*. Of these, four species had been pointed out and named by Mr. James, and one, *attritus*, we have elsewhere shown to be, probably, merely a peculiarly worn form of *Monticulipora fibrosa*. The reason given by Prof. Nicholson for using *Chætetes* instead of *Monticulipora* does not seem to have been very convincing to himself, and we have no doubt, will be sufficient to convince nearly every one, that if such is the best argument, that can be adduced in favor of calling our corals *Chætetes*, the sooner it is wholly abandoned and *Monticulipora* substituted the better it will be for our nomenclature.

Mr. Aug. R. Grote and W. H. Pitt of Buffalo, New York, have described a new Crustacean, from the water-lime group, allied to the *Eurypterus*, for which, they have proposed the name *Eusarcus Scorpionis*.

Prof. James Hall, of Albany, New York, has disposed of his large and unequalled collection of fossils, to the Central Park Museum of New York city. It is reported that the sale was effected in consideration of sixty-five thousand dollars.

OBITUARY.

Sir William Logan, the distinguished Geologist, died at London, in June last, in his 79th year. He was at the head of the Geological Survey of Canada from 1843 to 1871, and his work is an everliving monument of original investigation, extreme care, and profound knowledge of Stratigraphical Geology. He never dealt in far fetched suppositions, and extravagant theories, but sought the facts, and demonstrated his discoveries, in the plainest, most forcible and clear language to be found, in American Geological Reports.

G. P. Deshayes, the distinguished paleontologist, died, at Paris, on the 9th of June last, in his 79th year.

Dr. I. A Lapham of Milwaukee, Wisconsin, died on the 14th of September. He was best known for his labors in archæology, though he was also a good geologist. He wrote up the Mound-builders of his State under the title of "Antiquities of Wisconsin," which was published, with numerous plates and illustrations, by the Smithsonian Institution.

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